Dhyana XV95
User Manual

V1.0.3

Tucsen Photonics Co., Ltd.

Contents

1. Introduction

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1.2. Safety and warning information

Operation and Use

Caution	● Do not drop, disassemble, repair or replace internal components on your own. Such action may damage the camera components or cause personal injury. ● In the event of spillage on the equipment, please disconnect the equipment and immediately contact the nearest dealer or manufacturer for technical assistance. ● Do not touch the device with wet hands, as it may cause electric shock. ● Do not let children touch the device without supervision. ● Ensure that the temperature of the camera is within the specified temperature range for use to avoid damage.

Installation and maintenance

Caution	● Please do not install it in dusty and dirty areas or near air conditioning or heaters to reduce the risk of camera damage. ● Avoid installation and operation in extreme environments such as vibration, high temperature, humidity, dust, strong magnetic fields, explosive/corrosive gases or gases. ● Do not apply excessive vibration and impact to the equipment. This may damage the equipment. ● Do not install equipment under unstable lighting conditions. Severe lighting changes can affect the quality of the images generated by the device. ● Do not use solvents or diluents to clean the surface of the equipment, as this will damage the surface of the casing.

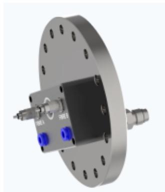
Power

Caution	● Please use the original power adapter of the camera, as using an mismatched power source may damage the camera. ● If the voltage applied to the camera is greater than or less than the nominal voltage of the camera, the camera may be damaged or malfunction. ● Please refer to the specification table for the nominal voltage of the camera.

2. Product specifications

2.1. Packaging List

Standard Item Name	Specification	Quantity	Image
sCMOS scientific grade camera	Dhyana XV95	1	
Camera control box	Including power and data interfaces	1	
External power cable for vacuum chamber	8-core cable, power and trigger	1	
Internal power cable for vacuum chamber	8-core vacuum cable, power and trigger	1	
Control box AC power cord	3-core 200~240V/2.0A 50/60Hz input	1	
USB3.0 data cable	2 m	1	
FC-LC fiber optic cable	2 m (outside vacuum chamber)	1	
FC-FC armored fiber optic cable	1.5 m (inside vacuum chamber)	2	
Fiber optic adapter	FC connector circular adapter	6	

USB flash drive	Software and Drivers	1	
Water pipes	2 m, OD: 6 mm, ID: 4 mm	2	
Stainless steel tubing	¼VCR male nut to ¼VCR female nut, 1 m	2	
DN100 CF flange	1/4 VCR tube fitting (male), quick-connect fitting, including through-wall socket, fiber feed-through	1	
VCR gasket	¼VCR clawed nickel gasket	10	

2.2. Camera Introduction

Dhyana XV95 is a professional soft X-ray sCMOS camera developed by Tucsen. It features a new generation of back-illuminated sCMOS sensor with non-anti-reflection coating, significantly enhancing quantum efficiency within the photon energy range of 80-1000 eV. Overall quantum efficiency exceeds 90%, with some bands approaching nearly 100%, achieving exceptionally high levels. It offers advanced capabilities in soft X-ray and extreme ultraviolet imaging, as well as radiation resistance, making it successfully applied in numerous international and domestic synchrotron-related research projects.

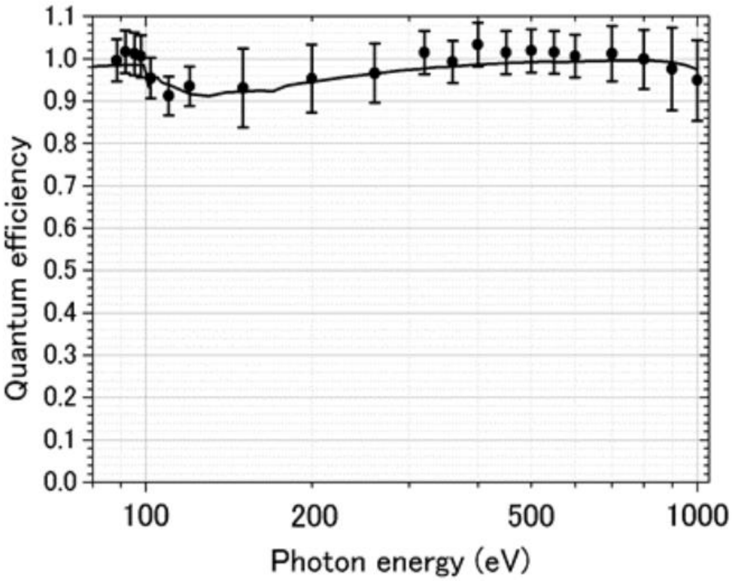


Figure 2-1 Quantum efficiency curve of Dhyana XV95

Vacuum compatibility up to 10^{-6} Pa

Utilizing Tucsen advanced cryogenic sealing technology, the Dhyana XV95 camera achieves an exceptionally high vacuum compatibility level of up to 10^{-6} Pa. With water cooling (20°C), it can reach a maximum cooling temperature of -45°C, significantly reducing dark current noise in the camera and extending the application time for long exposures.

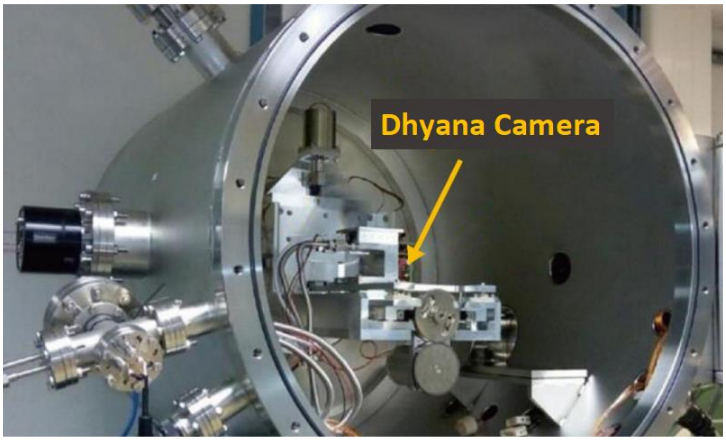


Figure 2-2 Schematic diagram of the camera in the vacuum chamber

High-speed, high-dynamic imaging advantages

Back-illuminated sCMOS technology offers imaging speeds tens of times faster than CCD technology, coupled with a significantly higher overall dynamic range advantage. As shown in the figure, in the acquisition of soft X-ray diffraction patterns, it achieves a peak diffraction order of 6.

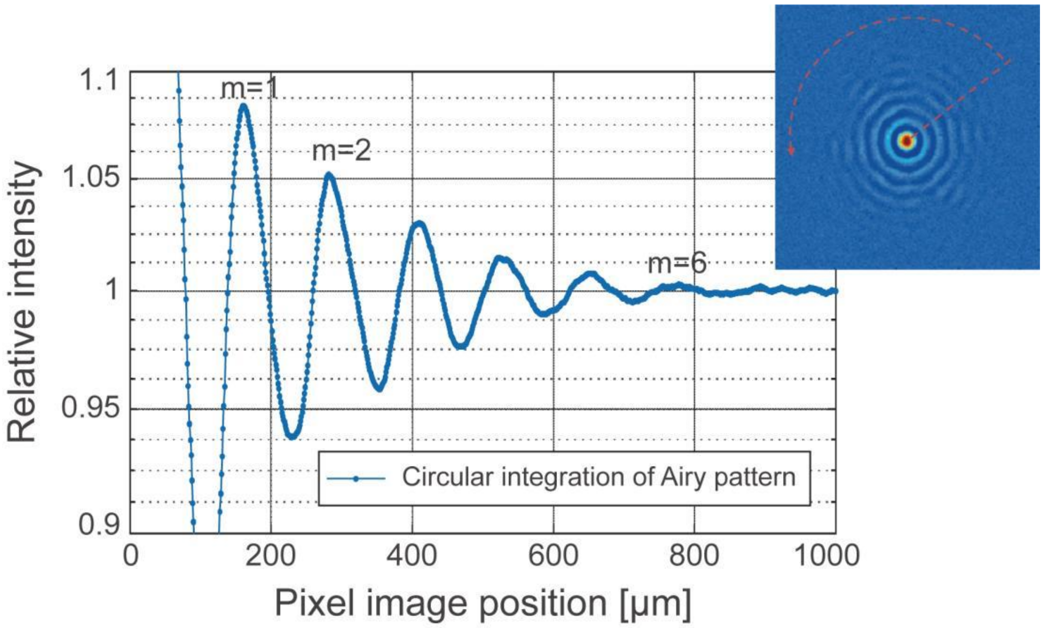


Figure 2-3 Soft X-ray diffraction pattern

2.3. Camera Power and Signal Connections

This section introduces the interfaces used during the camera installation process. Please ensure you have thoroughly understood the instructions in this section before proceeding with installation.

2.3.1. Camera Body

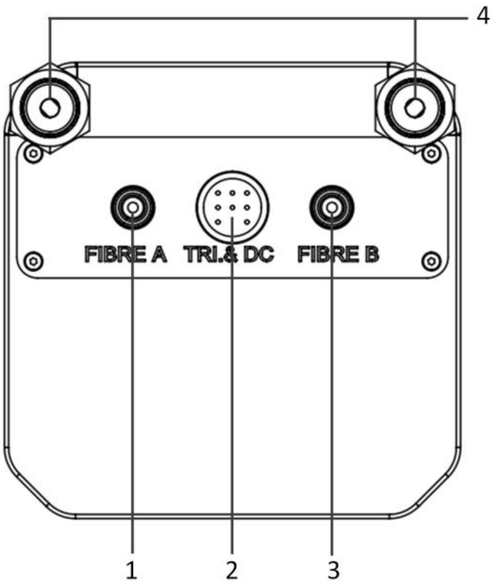


Figure 2-4 Camera Interface Diagram

No.	Name	Fuction
1	FIBRE A	Camera side fiber optic interface A is connected to the flange vacuum side fiber optic interface A for data transmission.
2	TRI.&DC	Power and trigger interface is connected to the flange vacuum side power and trigger interface.
3	FIBRE B	Camera side fiber optic interface B is connected to the flange vacuum side fiber optic interface B for data transmission.
4	Liquid VCR	VCR female connector, camera side water cooling interface, used for water cooling circulation.

2.3.2. Vacuum Flange

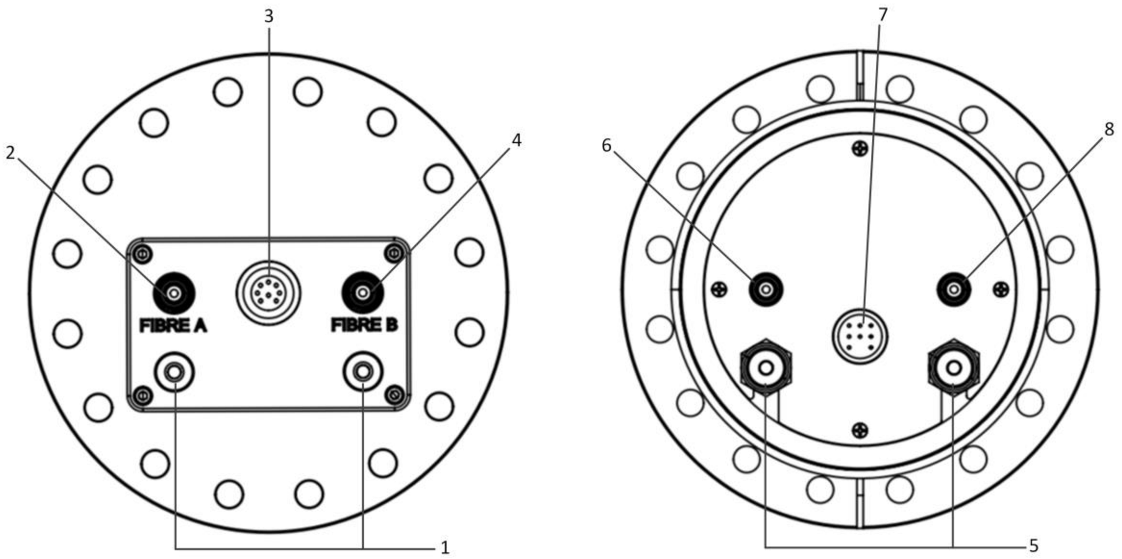


Figure 2-5 Diagram of the Feed Through Flange Interface, with atmospheric side connection on the left and vacuum side connection on the right.

No.	Name	Fuction
1	Water cooling interface	Atmospheric side water cooling interface on the flange is connected to the water circulation equipment via an outer diameter 6 mm flexible hose.
2、8	FIBRE A	Flange side fiber optic interface A is connected to the fiber optic interface on the control box for data transmission.
3、7	Power&Trigger	Flange side power and trigger interface is connected on the atmospheric side to the control box and on the vacuum side to the camera.
4、6	FIBRE B	Flange side fiber optic interface B is connected to the fiber optic interface on the control box for data transmission.
5	Liquid VCR	VCR male connector on the flange vacuum side water cooling interface is connected to the VCR connector on the camera side for water cooling circulation.

2.3.3. Control Box

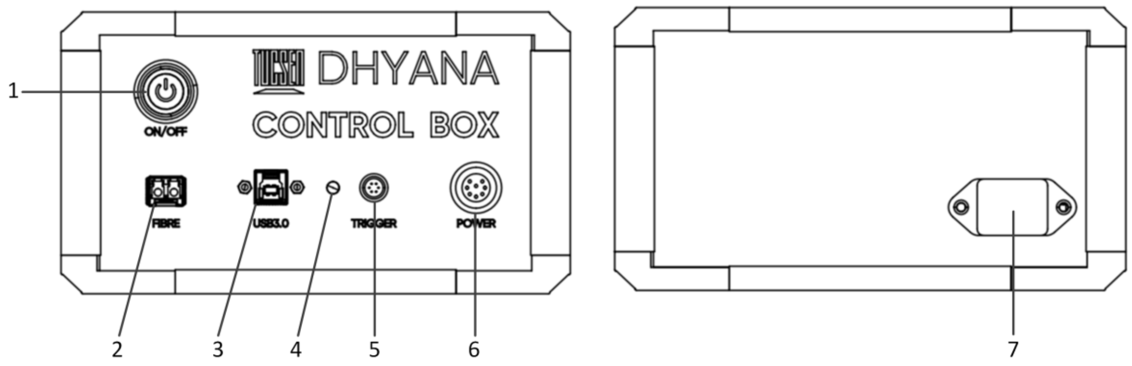
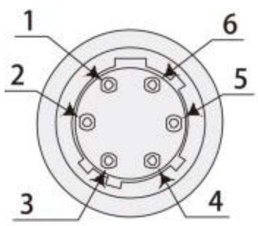
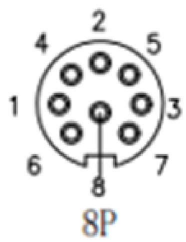


Figure 2-6 Control Box Interface Diagram

No.	Name	Fuction
1	Switch	Control box switch
2	FIBRE	Two fiber optic interfaces A & B, connected to flange atmospheric side fiber ports
3	USB 3.0	USB 3.0 locking data transfer interface, connected to the computer host for data transmission
4	Indicator light	Indicator of camera status: Red: Camera powered on but not connected Blue: Camera connected but no signal Green: Camera operating normally
5	Trigger	6-pin trigger signal Hirose connector,Model: HR10A-7R-6PB (73), supporting external trigger input and output, The definitions and default outputs for each pin are as follows:  Pin1：Trigger In; Pin2：GND; Pin3：NC; Pin4：TRI_OUT0, Readout End, Port1 Pin5：TRI_OUT1, Global Exposure, Port2 Pin6：TRI_OUT2, Exposure Start, Port3

6	Power	8-pin aviation plug (Model: M16-DB-Z8/RuiFan), for control box trigger signal and power connection, used to connect to the flange atmospheric side power and trigger interface  Pin1：GND, Power ground; Pin2：ISO1_OUT+, Camera Trigger Input 1,3.3V TTL 24mA; Pin3：24VCC, 24V Power output; Pin4：ISO0_OUT+, Camera Trigger Input 0,3.3V TTL 24mA; Pin5：ISO2_OUT+, Camera Trigger Input 2,3.3V TTL 24mA; Pin6：GND ,power ground; Pin7：24VCC, 24V power output; Pin8：ISO0_IN+, Trigger output,3.3V TTL;
7	AC power socket	Supports 200~240V AC, 2.0A, 50/60Hz input, control box power supply interface

2.3.4. Connection Logic Diagram

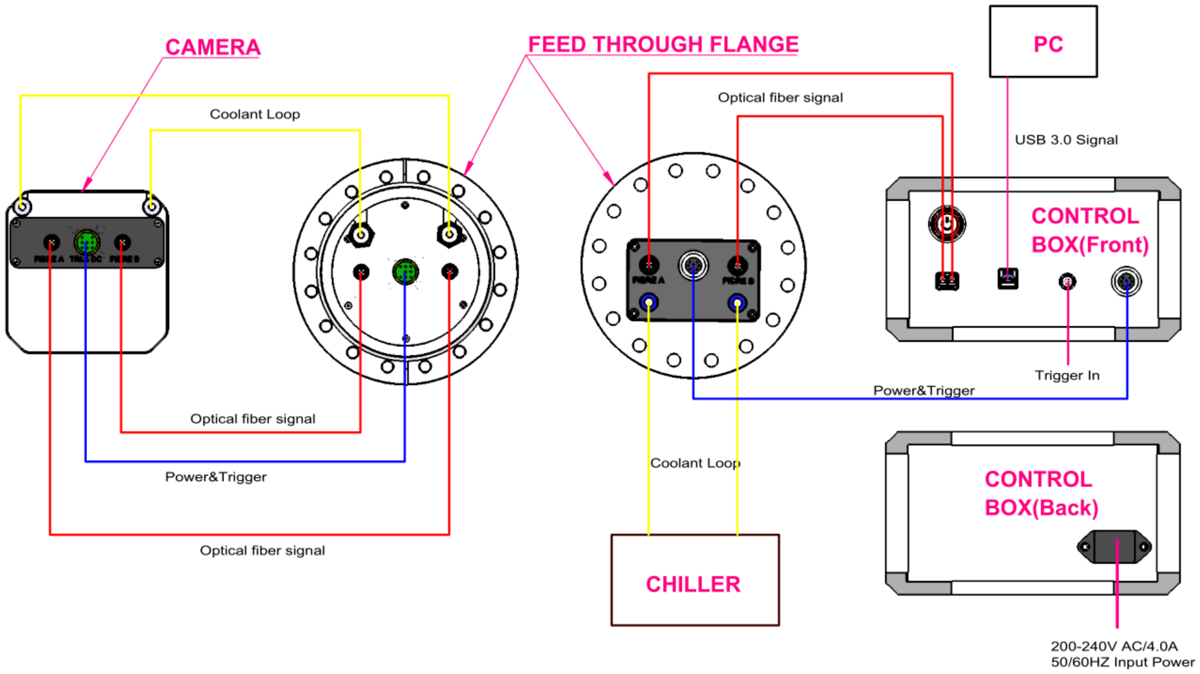


Figure 2-7 Camera Connection Diagram

Name	Explanation
CAMERA	The camera body is typically placed inside the vacuum chamber.*
FEED THROUGH FLANGE	The through-wall flange has one side facing the vacuum chamber (left) and the other side facing the atmospheric side (right).
CHILLER	Water cooling equipment.
CONTROL BOX	Control box, with both front and back shown in the diagram.
PC	Control terminal such as a computer.
Coolant Loop	Yellow lines represent the water cooling circulation.
Optical fiber signal	Red lines represent the fiber optic transmission channels.
Power&Trigger	Blue lines represent the power and trigger channels.

*** Precautions for Camera Use Outside of Vacuum:**

1) In normal situations: water cooling is required, and TEC (thermoelectric cooler) must be turned off.

2) In emergency situations: If water cooling is unavailable and the camera is used briefly (take a few images then turn off), you can use a fan to blow air over the camera casing for heat dissipation. TEC must be turned off as well.

3) During non-vacuum use, do not remove the camera protective cover. Ensure the camera surface remains clean to avoid affecting future vacuum use.

3. Features and Functions

3.1. Structure and Operation of sCMOS

Scientific grade complimentary metal-oxide semiconductor (sCMOS) cameras are specialized cameras used for scientific research and high-performance imaging. They combine the advantages of CMOS and Charge coupled device (CCD) technologies, featuring high speed, low noise, and high sensitivity, and are widely used in scientific research, biomedical imaging, optical microscopy, and other fields.

The structure of an sCMOS camera sensor typically includes the following components:

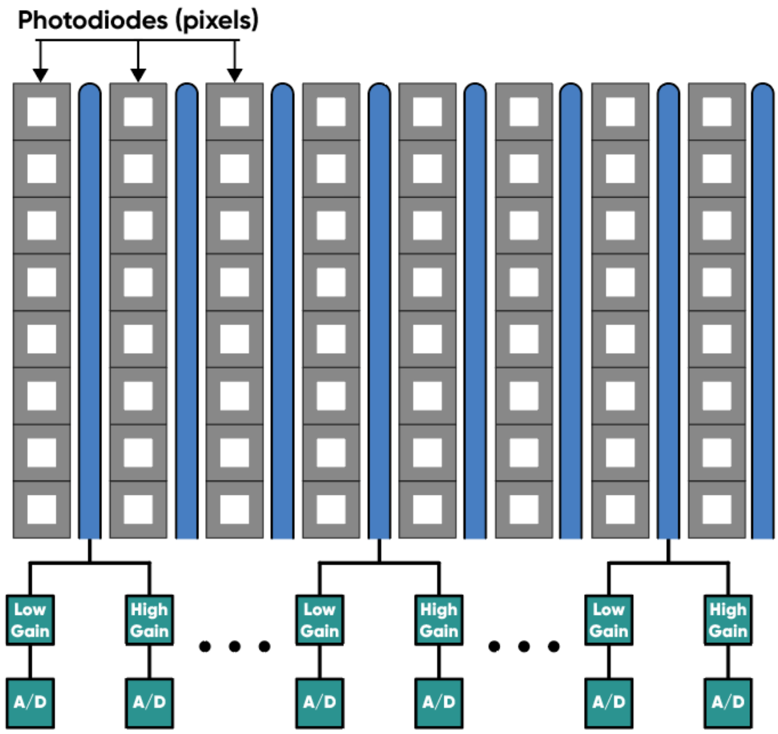


Figure 3-1 sCMOS camera sensor structure

1) Light-sensitive sensor array: sCMOS cameras use sCMOS sensor arrays (also known as image sensors) to capture light signals. These sensors consist of many photosensitive units that convert light into charge signals.

2) Gain amplifier: Each photosensitive unit in an sCMOS camera is equipped with an independent gain amplifier to amplify the charge signal and convert it into a voltage signal.

3) Analog-to-digital converter (ADC): The amplified analog signal is digitized through an analog-to-digital converter (ADC) inside the camera, converting it into a digital signal for further processing and storage.

sCMOS cameras typically also include an image processing unit for performing image enhancement, correction, and other image processing algorithms. The digitized image undergoes these processes to obtain higher-quality images.

The operation process of an sCMOS camera is as follows:

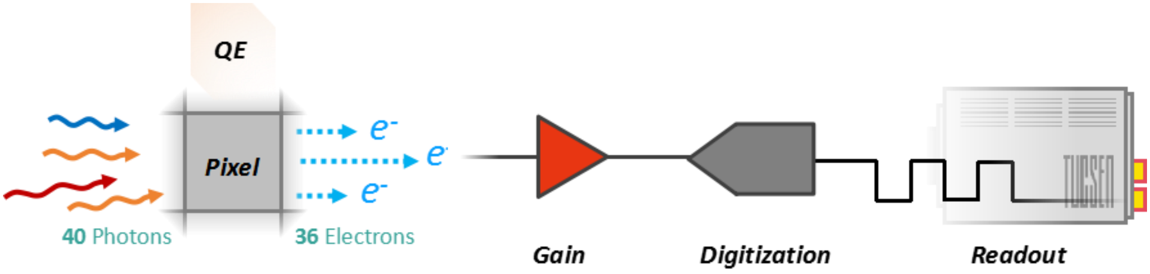


Figure 3-2 sCMOS operation process

1) Light signal capture: When photosensitive units are exposed to light, the light is converted into charge signals and stored in each unit.
2) Signal amplification: The charge signals from each photosensitive unit are amplified by corresponding gain amplifiers and converted into voltage signals.
3) Digitization: The amplified analog signals are converted into digital signals by an ADC for processing and storage.
4) Image processing: The digital signals undergo various algorithmic processes such as denoising, enhancement, and color correction through the image processing unit.
5) Data output: Processed image data can be transmitted to computers or other devices for display, analysis, and storage through various interfaces such as USB, Ethernet, etc.

3.2. Shutter Mode

The Dhyana XV95 camera uses a rolling shutter readout mode. In this mode, the camera reads out rows sequentially, with consistent exposure time for each row, but different starting exposure time point for different rows. The difference in exposure time points between adjacent rows is also known as the line time (T_{line}).

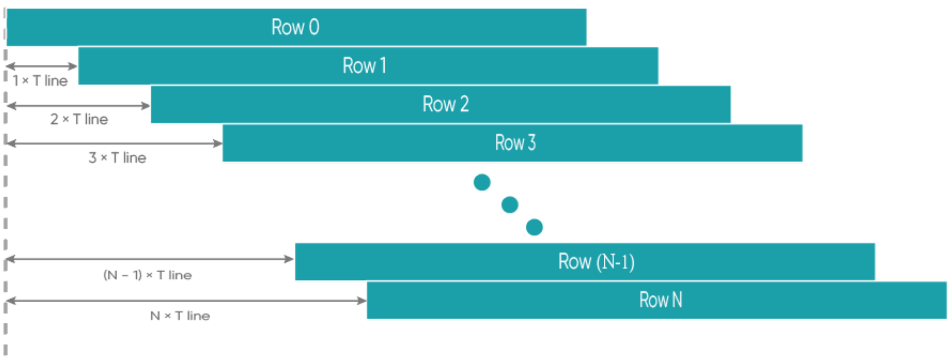


Figure 3-3 Rolling shutter diagram

In rolling shutter mode, if the camera is not synchronized with external light sources or if flickering light sources are present, it may result in striped images. This effect is especially noticeable with short exposure times(Please refer to the FAQs for solutions).

3.3. Front-Illuminated and Back-Illuminated sCMOS Technology

Cameras based upon sCMOS technology typically use two types of chips: front-illuminated (FSI) and back-illuminated (BSI). In front-illuminated cameras, light entering the pixels must pass through metal circuit structures before being detected. Due to the non-transparency of metal circuit structures, early cameras had only about 30-40% quantum efficiency (QE). Later, with the introduction of microlenses, light was focused through the conductors onto the photosensitive silicon, increasing QE to around 70%. Some advanced front-illuminated cameras can even achieve a peak QE of around 84%.

Back-illuminated cameras reverse this sensor design by placing the metal circuitry behind the photosensitive silicon layer, allowing incident photons to directly strike the thin photosensitive silicon layer. This process innovation significantly increases the peak QE of back-illuminated cameras and improves imaging quality in low-light environments. Due to the thin photosensitive silicon layer of back-illuminated pixels, there are higher process requirements and production difficulties compared to front-illuminated ones.

The Dhyana XV95 camera uses an non-anti-reflection coated back-illuminated sensor, with peak QE reaching approximately 100% in certain spectral bands.

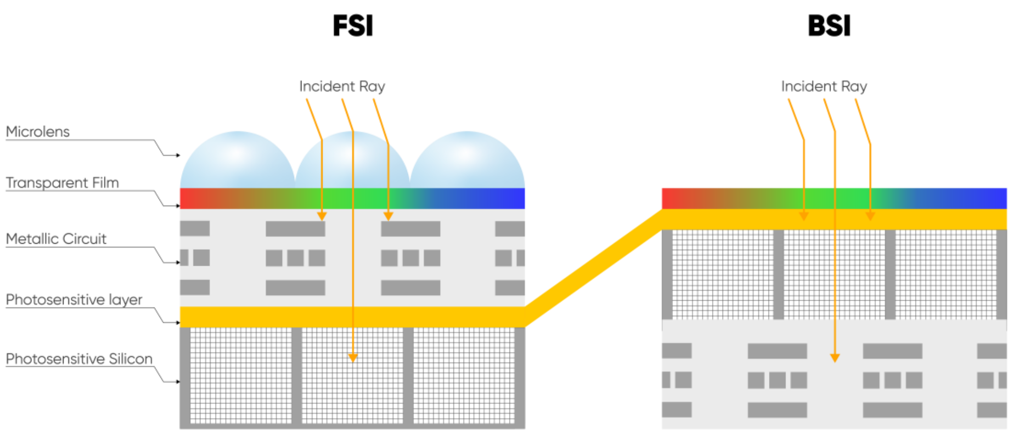


Figure 3-4 Front-Illuminated and Back-Illuminated diagram

3.4. Readout Noise

Noise is a description of the uncertainty of a signal. The noise introduced by the circuit when reading the signal is called readout noise. Readout noise dominates in low signal level imaging, and excessive readout noise can limit the applications of imaging under weak light conditions.

In CCD cameras, since all pixels share the same readout circuit, the standard deviation (σ) of each pixel is relatively uniform, so a unified value can be used to represent the overall level of readout noise. In sCMOS cameras, each pixel has its own readout circuit, and the statistical distribution of readout noise for all pixels can be obtained as shown in the graph below. The camera's readout noise is typically represented by the median and root mean square (RMS). The median represents the median of the standard deviations of all pixels, while the root mean square reflects the overall noise situation, with the RMS value usually higher than the median value.

To accurately measure readout noise, it is usually evaluated by acquiring multiple dark frame images under no light signal and the shortest exposure condition, and calculating the time-domain standard deviation of each pixel to assess its readout noise level.

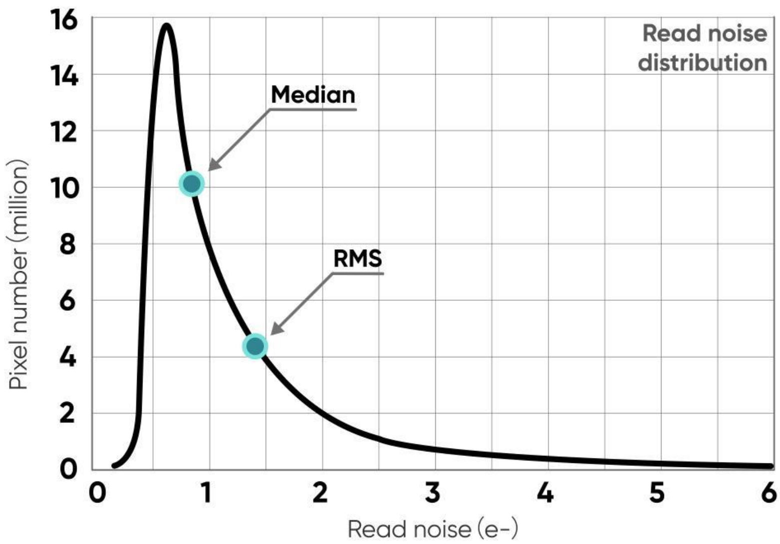


Figure 3-5 Readout noise distribution of an typical sCMOS camera

3.5. Defective Pixel Correction (DPC)

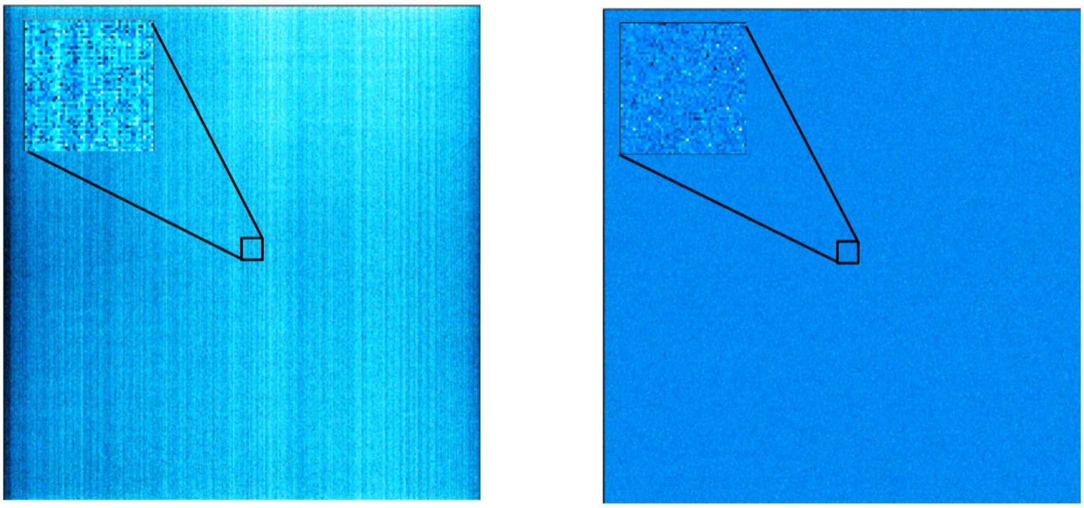
There are always a few abnormal values on the sCMOS camera chip. Through the camera's Defective Pixel Correction (DPC) function, these abnormal points can be corrected, removing defective pixels from the image. However, this may cause flickering pixels in some single-molecule imaging applications. It is not recommended to use the DPC function for these applications or to use only the weakest correction level.

The Dhyana XV95 adopts dynamic defective pixel correction, correcting using a 3x3 matrix of pixels. Currently, four correction levels are available, each corresponding to different thresholds, thereby controlling the intensity of defective pixel correction.

3.6. Dark Signal Non-Uniformity (DSNU)

When the camera captures images in complete darkness, ideally, all pixel grayscale values should be close to zero and equal. However, in reality, when the camera captures images in darkness, subtle differences in the performance of each pixel in the sensor will cause some variations in the pixel grayscale values outputted from the camera.

In practical applications, when there are no photons incident on the camera, the obtained image usually does not show a grayscale value of 0 (DN). This is because manufacturers typically set a offset value, such as 100 grayscale values, to account for the influence of noise on measurements based on this baseline in the absence of light. However, without careful calibration and correction, this fixed offset may also vary between different pixels. This variation is called "fixed pattern noise" and can be measured by DSNU (Dark Signal Non-Uniformity). It represents the standard deviation of pixel bias, measured in charge units.



Before correction 1.6 e-　　　　After correction 0.2 e-

Figure 3-6 DSNU correction comparison before(left) and after(right)

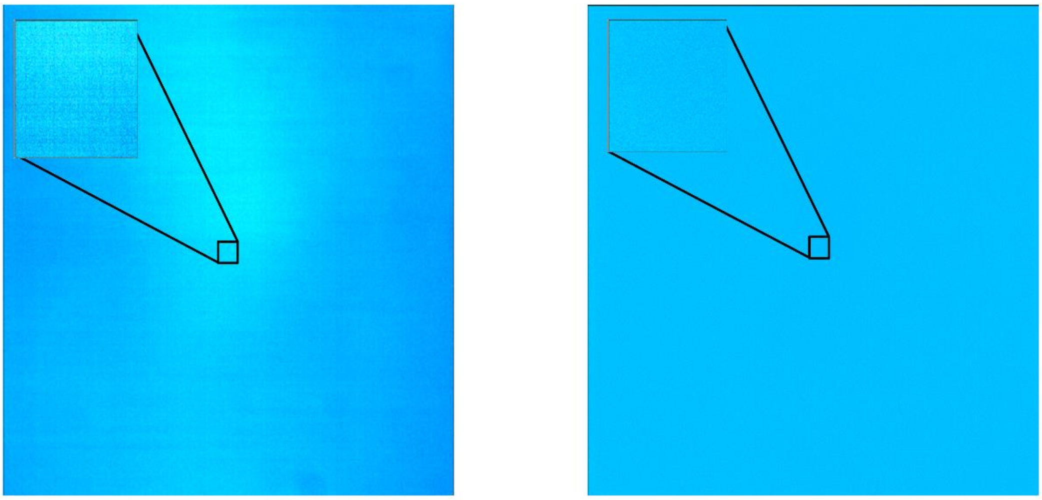
For many low-light imaging cameras, DSNU is typically less than 0.5 e-. This means that in medium or high light level applications (where each pixel can typically capture hundreds or thousands of photons), the influence of this noise can be completely negligible. Moreover, even for low-light applications, if DSNU is lower than the camera's readout noise (typically 1-3 e-), this fixed pattern noise is unlikely to affect image quality.

3.7. Photo Response Non-Uniformity (PRNU)

When a camera captures uniformly illuminated light targets under bright light conditions, ideally, all pixel grayscale values should be close to the maximum grayscale value and equal. However, in reality, there are subtle differences in the performance of camera pixels, causing changes in pixel grayscale values outputted from the camera due to variations in lenses or illumination.

When the camera detects light signals, the number of photoelectrons captured by each pixel during the exposure process is measured and transmitted as digital grayscale values (DN) to the computer. The conversion from electrons to DN follows a certain proportion, called the system gain (K) or conversion gain, plus a fixed offset (usually 100 DN). These values are determined by both the analog-to-digital converters and amplifiers used for conversion. sCMOS cameras use parallel transmission, with one or more analog-to-digital converters per column of the camera and one amplifier per pixel, resulting in slight variations in pixel gain and offset.

Under dark field or low light conditions, differences in offset can be measured by DSNU as mentioned in Section 3.6. In bright environments, the influence of gain also needs to be considered. Differences in gain and offset changes are measured by Photo Response Non-Uniformity (PRNU), which is the ratio of detected electrons to displayed DN. Given that the intensity values produced will vary depending on the signal size, PRNU is expressed as a percentage.



Before correction 1.6% After correction 0.3%

Figure 3-7 PRNU correction comparison before(left) and after(right)

Typical PRNU values are < 1%. For all low-light and medium-intensity light source imaging (signals of 1000 e- or less), this variation is negligible compared to readout noise and other sources of noise. Similarly, when imaging at high light levels, this variation is not significant compared to other noise sources in the image (such as photon shot noise). However, in high light level imaging applications requiring very high measurement accuracy, especially those using frame averaging or frame summation, PRNU values < 1% are highly necessary.

3.8. Gain Mode

The XV95 camera has five operating modes: High Dynamic Range (HDR), High Gain (HG) / Low Gain (LG) in HDR mode, and High Gain High-Speed (HG_HS) / Low Gain High-Speed (LG_HS). Each mode differs in its synthesis principles, gain values, saturation capacity, and readout noise. You should select the appropriate mode based on the actual scene to achieve high-quality imaging results.

Table 3-1 Typical gain mode parameter table*

Mode	HDR（16bit）	High Gain（12bit）	Low Gain（12bit）
System gain (DN/e-)	0.75	1.98	0.043
Full-Well Capacity (e-)	80000	1900	85000
Readout noise (e-)	2.4 (Median) 2.5 (RMS)	1.6 (Median) 1.7 (RMS)	45 (Median) 50 (RMS)

***Note:**

The values in this table are typical and may vary between different cameras. Please refer to the factory photoelectric report for specific details.

3.8.1. High Dynamic Range

High Dynamic Range (HDR) mode synthesizes images with different analog gains but the same exposure time. It includes Low Gain (LG) mode with high full well capacity and high noise suitable for imaging strong signals, and High Gain (HG) mode with low full well capacity and low readout noise suitable for imaging weaker signals. Combining high and low gain images through algorithms generates an HDR image. This mode is suitable for applications with large variations in signal strength.

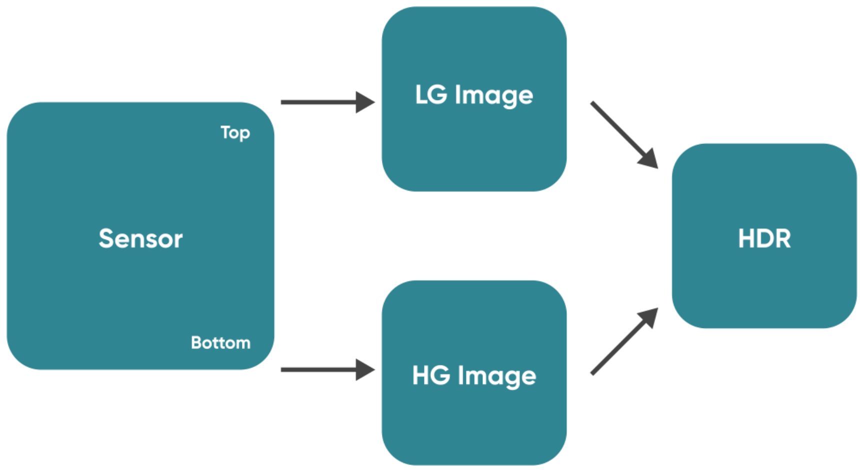


Figure 3-8 Schematic diagram of HDR mode

3.8.2. High Gain

The High Gain (HG) mode has lower readout noise and is suitable for imaging scenarios with weaker signals.

3.8.3. Low Gain

The Low Gain (LG) mode has a higher full well capacity, making it suitable for imaging scenarios with strong signals.

3.8.4. High Speed

In High speed mode (HS), unlike the normal rolling shutter readout method, both the High Gain (HG) and Low Gain (LG) channels are set with identical parameters, allowing for simultaneous readout of odd and even rows of data. This configuration doubles the readout speed.

High-Speed mode can be configured in two gain settings: "High Gain High-Speed (HG_HS)" and "Low Gain High-Speed (LG_HS)." The "High Gain High-Speed" setting is optimized for readout noise, while the "Low Gain High-Speed" setting is optimized for saturation capacity.

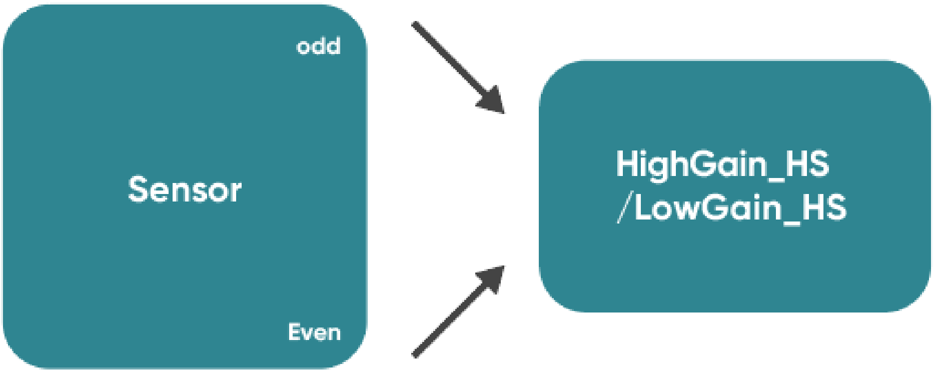


Figure 3-9 Schematic diagram of High speed mode

Note:

The high-speed mode is also known as the STD mode.

3.9. Region of Interest Readout

In imaging applications, ROI (Region of Interest) defines a subregion of interest within the camera sensor's resolution range, and selecting an ROI allows only the images within this subregion to be read out. Rolling shutter cameras can increase the camera's readout speed by reducing the number of rows. The software sets preset subregions and also supports manual settings, where the row window must be a multiple of 4, and the column window must be a multiple of 8.

The measured frame rates for typical ROI (Region of Interest) areas of the Dhyana XV95 camera are as follows:

Table 3-2 Frame rates (fps) for different ROI under USB 3.0 interface*

Column (Pixel)	Row (Pixel)	HDR&HG&LG	HighGain_HS/LowGain_HS
2048	2048	23.88	47.53
2048	1024	47.53	94.58
2048	512	94.58	188.18
2048	256	188.18	369.46
2048	128	372.41	717.24
2048	64	728.08	1354.68
2048	32	1394.69	2440.39
2048	16	2565.52	4071.85
2048	8	4431.10	6095.47
48	8	4433.50	6095.47

***Note:**

1) The minimum supported ROI for Dhyana XV95 on Mosaic V3 is 48 (columns) × 8 (rows).

2) Frame rates are affected by computer system configuration, and it is recommended to use a computer with an i5 processor or above and a 64-bit system.

3) For high-speed image acquisition, it is recommended to uncheck automatic levels and turn off the Image Adjustment module.

4) The frame rates in the above table are the measured maximum values under the shortest exposure time.

3.10. Binning Readout

Binning is a readout mode that recombines camera pixels, which can improve sensitivity but may also reduce resolution. For example, 2 x 2 binning combines every 4 pixels (2 rows 2 columns) into one "large pixel", and the camera outputs one pixel intensity value.

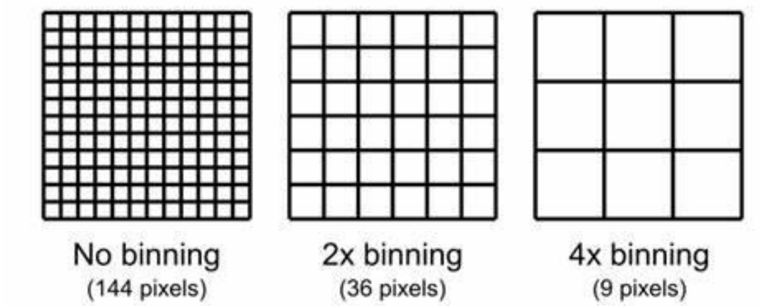


Figure 3-10 Schematic diagram of Binning

Binning can be performed by the camera's FPGA or by the camera operating software. Combining signals in this way can improve the signal-to-noise ratio, enabling the detection of weaker signals, improving image quality, or shortening exposure times. However, the effective pixel size of the camera also increases, which may reduce the camera's resolution of target details.

Binning data processing can be divided into Sum Binning and Average Binning. In 2 x 2 Binning, for example, Sum Binning adds the grayscale values of four pixels, while Average Binning adds the grayscale values of four pixels and then divides by 4 to obtain the average grayscale value.

The software Binning seclection on Mosaic V3 is shown below:

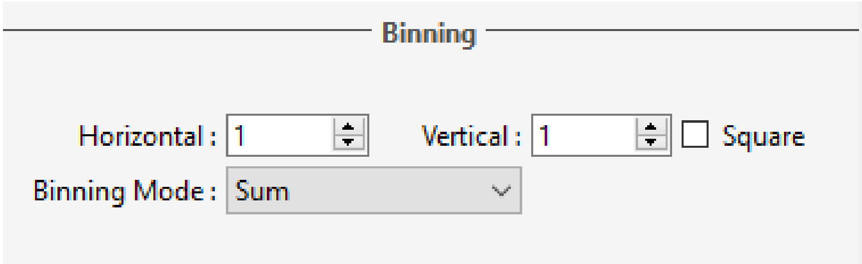


Figure 3-11 Software binning

The FPGA Binning seclection on Mosaic V3 is shown below:

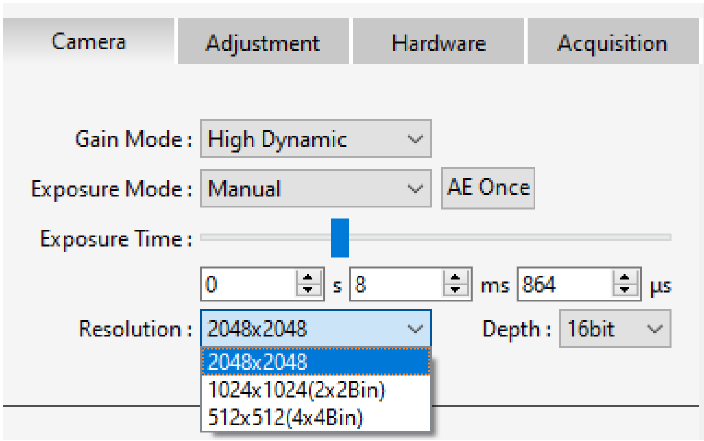


Figure 3-12 FPGA Binning

3.11. Timestamp

The camera accurately reads the start time of each frame with a time precision of 1 µs. In Mosaic V3 software, images are saved in .sen format, and timestamp information is displayed in the image information, supporting the export of image information to .csv format files.

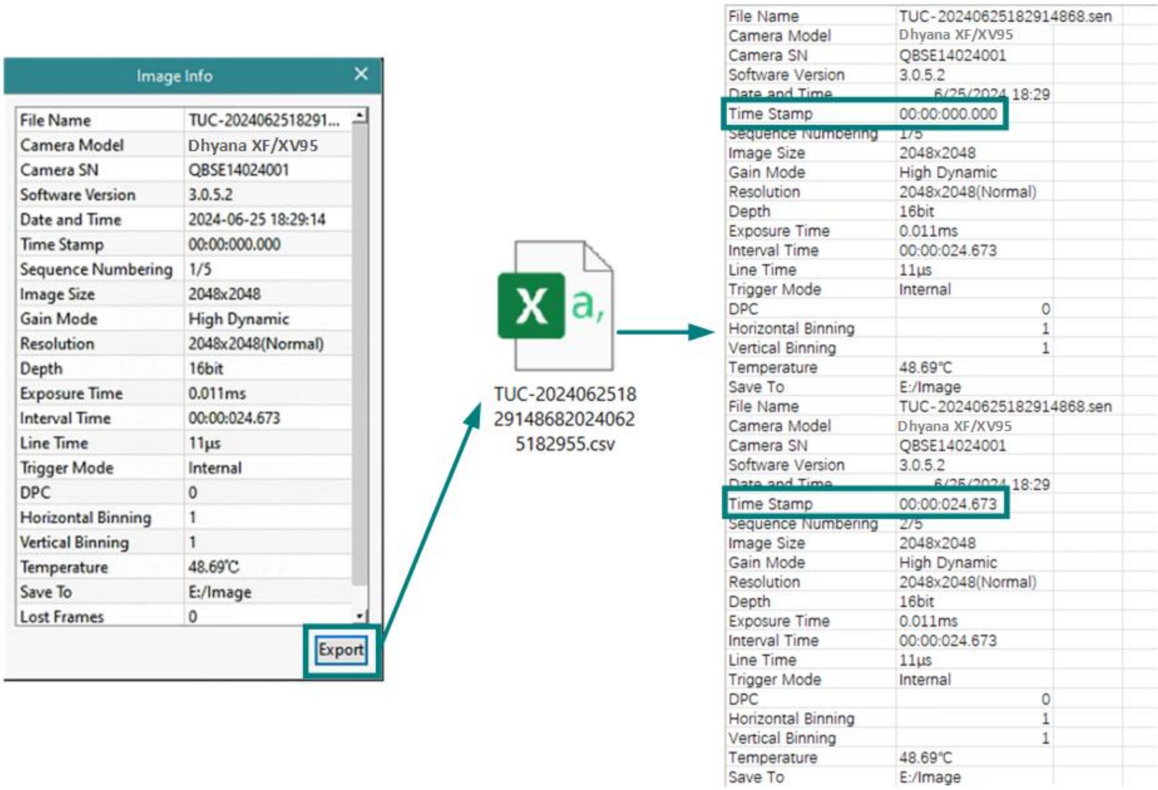


Figure 3-13 Illustration of the timestamp function in Mosaic V3 software

Note:

Applications requiring timestamp functionality generally have high time precision requirements, and it is recommended to use the To RAM image storage mode.

3.12. Frame Rate Calculation

The camera's frame rate is influenced by readout time and exposure time, and the final frame rate is also constrained by the transmission bandwidth. The Dhyana XV95 utilizes a USB 3.0 interface, with a maximum transmission bandwidth of approximately 320 MB/s.

Table 3-3 Calculating the line time and theoretical minimum full-frame readout time for each mode of the Dhyana XV95.

Gain mode	Line time T_{line}	Readout Time $T_{readout}$
HDR/HG/LG	20.52 µs	2048*20. 52 µs=42.02496 ms
HighGain_HS/LowGain_HS	20.52 µs	2048/2*20.52 µs=21.01248 ms

Typical frame rate calculations for USB 3.0

Where Hn: The number of rows selected horizontally; Vn: The number of rows selected vertically;T_{exp}*: The set exposure time;* Y_{U3}*: 40 fps(Maximum frame rate at full frame in USB 3.0)*

Table 3-4 Calculation of frame rate for XV95 camera

Gain mode	Calculation formula	Horizontal (Hn)	Vertiacal (Vn)	Frame rate (fps)	Gain mode
HDR/HG/LG	20.52 µs	$1/(Vn*T_{line})$	2048	2048	23.8
				1024	47.6
				512	95.2
				256	190.4
				128	380.7
				64	761.4
HighGain_HS /LowGain_HS	20.52 µs	$1/(Vn/2*T_{line})$	2048	2048	47.6
				1024	95.2
				512	190.4
				256	380.7
				128	761.4
				64	1522.9

Note:

1) The frame rate is affected by the actual transmission bandwidth and computer system configuration, and to prevent frame loss, the actual transmission will increase the interval time in units of line time, and the readout time will increase accordingly, resulting in part of the calculated frame rate may be greater than the actual frame rate;

2) The frame rate value in the table is calculated based on the minimum exposure time. When the exposure time (T_{exp}) is greater than the frame transfer time, the frame rate = $1/T_{exp}$ (s);

3.13. Incident Photon Calculation

Scientific camera imaging involves the conversion of photons, electrons, voltage, and grayscale values. Therefore, it is possible to reverse calculate the incident number of photons from the grayscale values. The calculation formula* is as follows:

$$P = \frac{(DN\text{-}Offset)/K}{Q(\lambda)}$$

Where:P represents the incident number of photons.DN is the grayscale value of the light signal. K is the system gain (refer to Table 3-1) in (DN/e-). Q(λ) corresponds to the quantum efficiency at the wavelength.Offset s the camera's background value in DN.

***Note:**

1) For high-energy photons, a single excitation may involve multiple photoelectrons. If precise photon counts are needed, it needs to be divided by the corresponding factor to get an accurate photon value. For example, the photon energy of 13.5 nm is about 92 eV, and a single excitation produces 92/3.66 ≈25 photoelectrons (statistically the energy of electron-hole pairs produced by silicon is about 3.66 eV). Therefore, the above formula for calculating the number of incident photons needs to be divided by 25 to get the final photon number.

2) The camera should not be exposed to light intensity exceeding 3/4 of the saturation grayscale value. Prolonged exposure to high-intensity light may damage the sensor.

3.14. Acquisition Mode

3.14.1. Live mode

Live mode is suitable for real-time preview, providing data stream output. Images are continuously output like a flowing stream. In this mode, users can freely modify settings such as exposure time, gain mode, region of interest, etc., for real-time preview and image capture operations.

After successfully installing the Mosaic V3 software and drivers, the hardware trigger mode defaults to "internal " (live mode), the user can click Preview/Stop to control the opening and closing of the camera live mode, and click Capture to obtain the image.

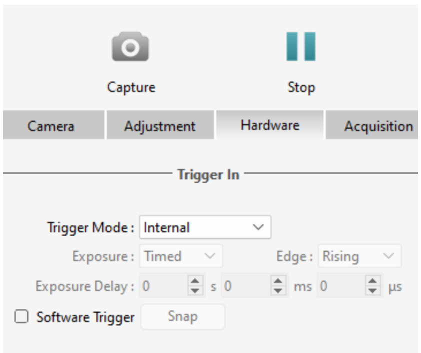


Figure 3-14

Users can set the exposure time, gain mode and other camera parameters, and preview them in real time through the preview window to get a suitable image.

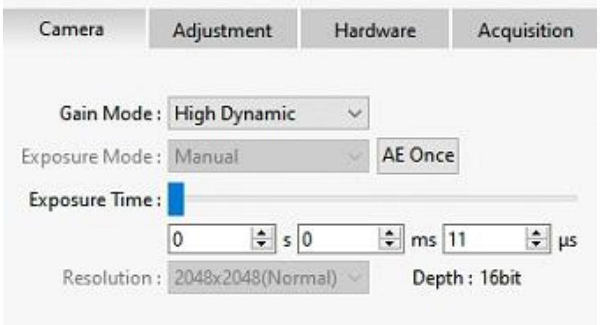


Figure 3-15

In the acquisition module, users can set the save path, file name, total number of frames and other information, and the image can be taken after the setting is completed.

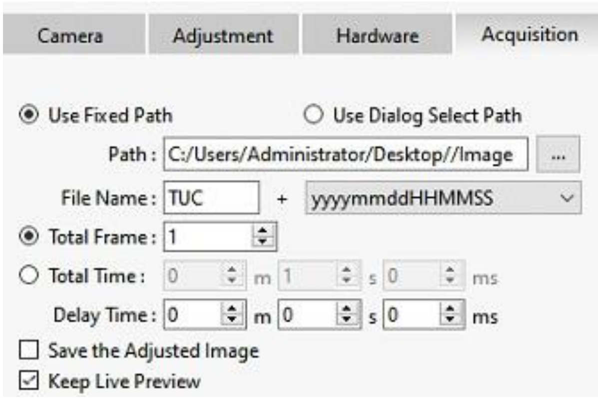


Figure 3-16

3.14.2. Software Trigger Mode

When the camera is in Software trigger mode, the software gives the camera a command to take a picture, and when the camera receives the signal, it starts the exposure and outputs the image.

To use the software trigger mode in Mosaic V3, check the software trigger, click Capture to enter the waiting trigger state, and then click the **Snap** to execute the image capture command, and only output one image at a time.

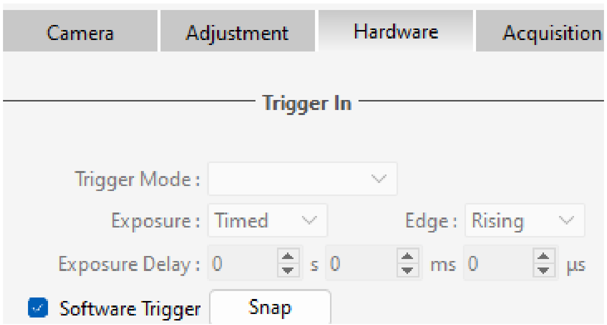


Figure 3-17

3.14.3. Hardware Trigger Mode

Hardware trigger mode waits for an external level trigger signal command to capture an image.

It includes two modes: Standard and Synchronization.

The Mosaic V3 software provides configurations such as mode, frames/signal, exposure, edge, exposure delay, etc., to control the number of triggered images captured continuously according to the set quantity.

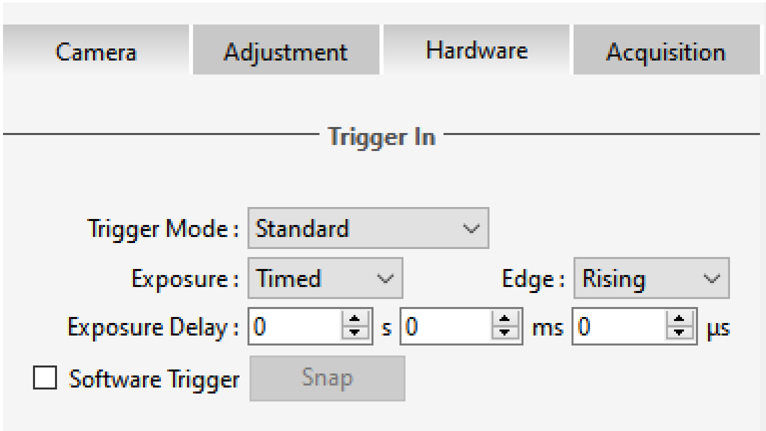


Figure 3-18

3.14.3.1. Hardware Trigger input circuit

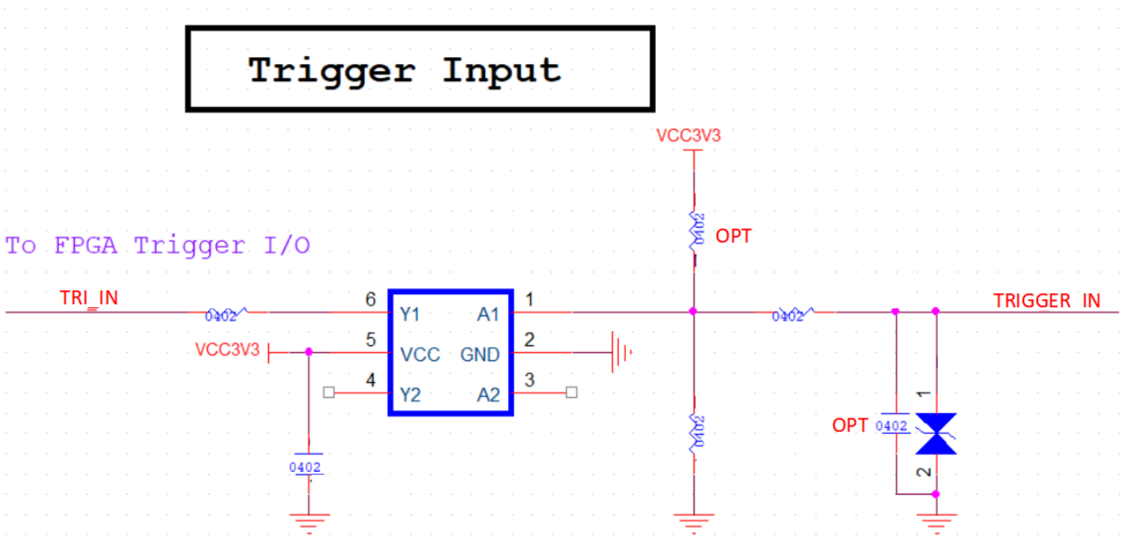


Figure 3-19 Hardware trigger input circuit

Note:

1) The valid external trigger signal recognized by the imager must be a level signal of 3.3 to 5 V. Exceeding the maximum voltage limit may cause permanent damage;

2) The pulse width of the recognized level signal must be greater than 1 µs.

3.14.3.2. Trigger Delay and Jitter

The trigger delay and jitter for the HDR, High Gain, Low Gain, and High Speed modes are shown below, When the external trigger signal arrives, there is a nanosecond-level delay T_{iso}. through the hardware circuitry. After the delay through the hardware circuitry, the level signal input to the camera's internal undergoes conversion, resulting in some jitter T_{logic}, ranging from 0-1 minimum exposure unit T_{line}. Therefore, the total delay time from external trigger input to exposure start is T_{idelay}=T_{iso} + T_{logic}, within the range of one line time.

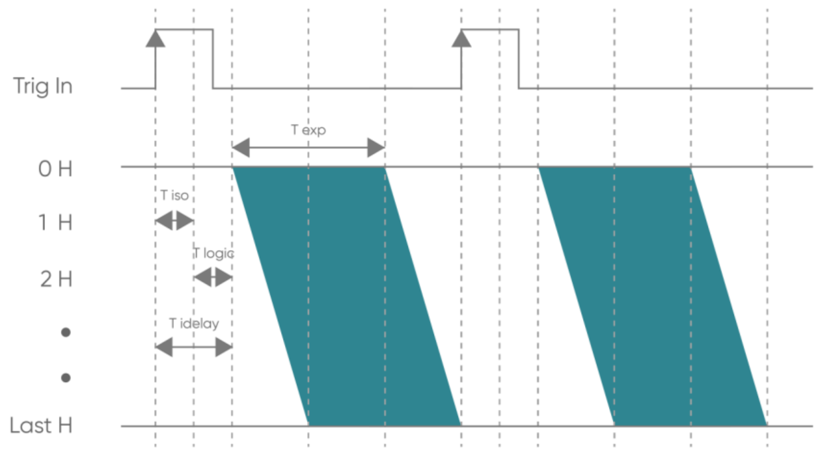


Figure 3-20 Schematic of trigger delay

T_{exp}: exposure time; T_{iso}: hardware circuit delay; T_{logic}: trigger jitter; T_{idelay}: total delay time;1H: one T_{line}

3.14.3.3. Standard Trigger Mode

In standard trigger mode, when the camera is in live mode, it can respond to the trigger signal immediately after the exposure of the first row of the image ends.

This mode supports two types of triggering: level triggering and edge triggering. In level triggering mode, exposure start and end are controlled by the rising or falling edge of an external trigger signal, with the duration of exposure determined by the duration of the level. Level triggering mode is not continuous shooting; it is commonly used for capturing stationary or slow-moving objects.

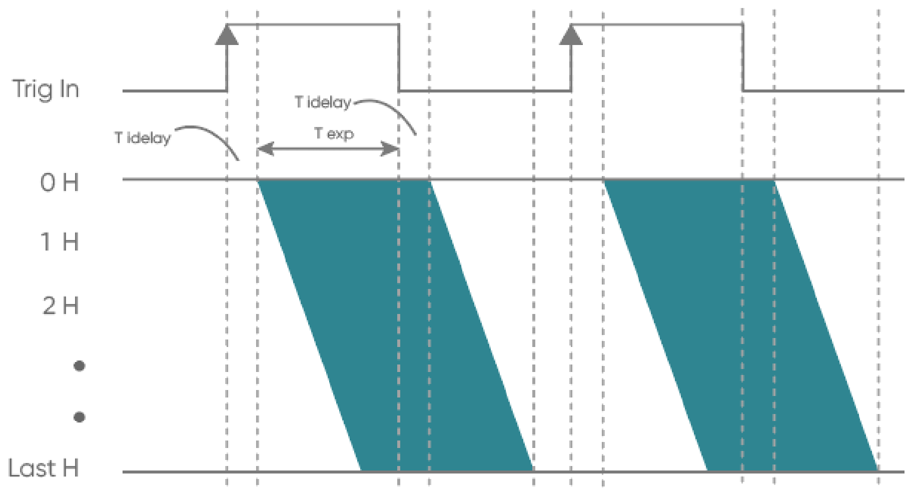


Figure 3-21 Level Triggering Mode

In contrast, in edge triggering mode, exposure duration is directly set in the software interface. When using this mode, it's crucial to ensure that the duration of each pulse cycle of the trigger signal (pulse width + pulse interval) is greater than or equal to the total time required for each frame image output (i.e., the reciprocal of the frame rate, including delay time, exposure time, and readout time). This ensures that each frame image is complete and error-free.

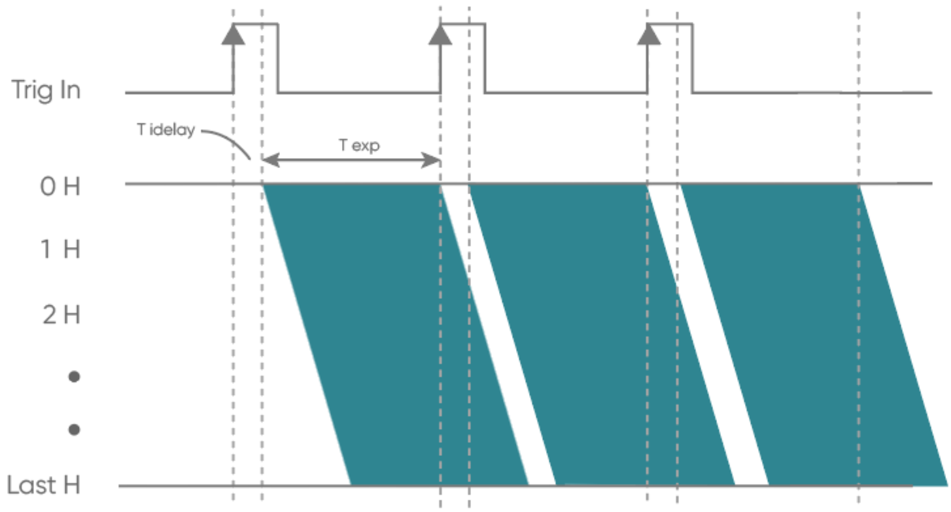


Figure 3-22 Edge Trigger timing diagram

3.14.3.4. Synchronization Trigger Mode

In this mode, when the camera receives a certain level signal, it starts exposure capture. When it receives the next level signal, it ends exposure, starts readout, and begins a new exposure cycle. This mode ensures complete synchronization of exposure start and readout with the external trigger signal.

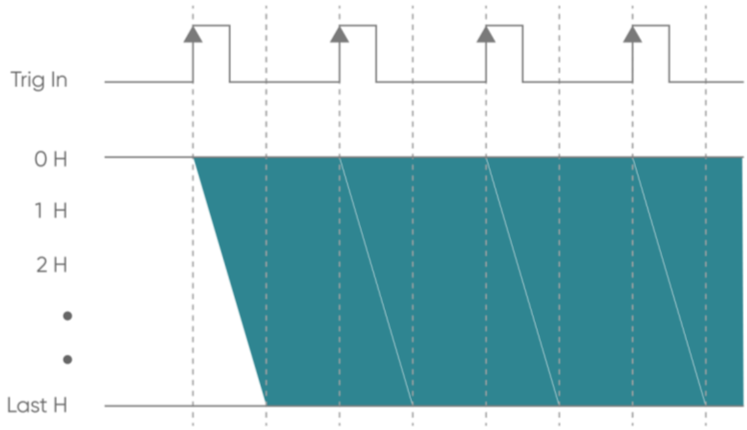


Figure 3-23 Synchronization Trigger mode timing diagram

The length of exposure time in this mode is determined by the time interval between the arrival of two trigger signal edges. After entering this mode, the camera starts the first frame exposure when the first trigger signal edge is detected, and does not terminate the first frame exposure and output the image until the trigger signal edge is detected for the second time, and at the same time starts the second frame exposure, and so on; that is, there is no image data for the first trigger signal after entering this mode, and there is an image output for each of the subsequent trigger signals, and the exposure time for each frame is the time interval between the arrival of the two trigger signal edges. The exposure time corresponding to each frame is the time interval between the arrival of the two trigger signal edges. The same mechanism is followed when the trigger signal is single pulse or multi-pulse.

This mode is very useful for confocal microscopy as it enables simultaneous control of the camera's exposure time and spinning disk confocal speed to eliminate the effects of inhomogeneous light.

3.15. Trigger Output

3.15.1. Hardware Trigger output circuit

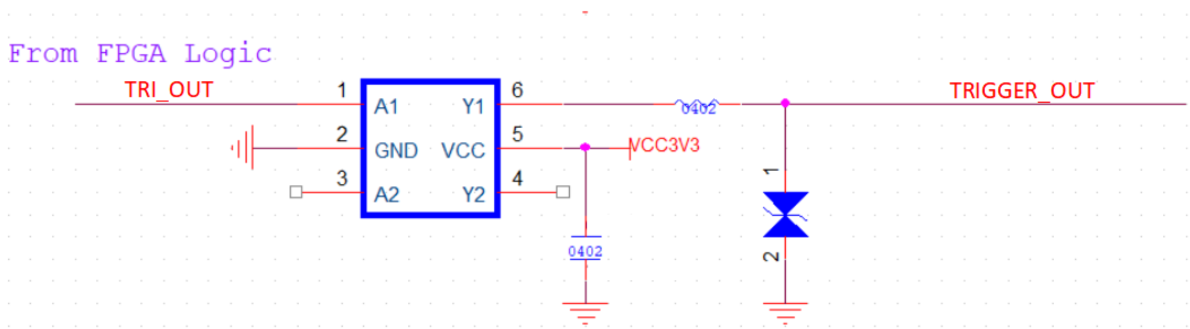


Figure 3-24

3.15.2. Trigger Output Timing Diagram

The camera has three external trigger output interfaces, each independently capable of outputting five timing signals. Each output signal can be independently configured on the three output ports and can simultaneously output to different devices.

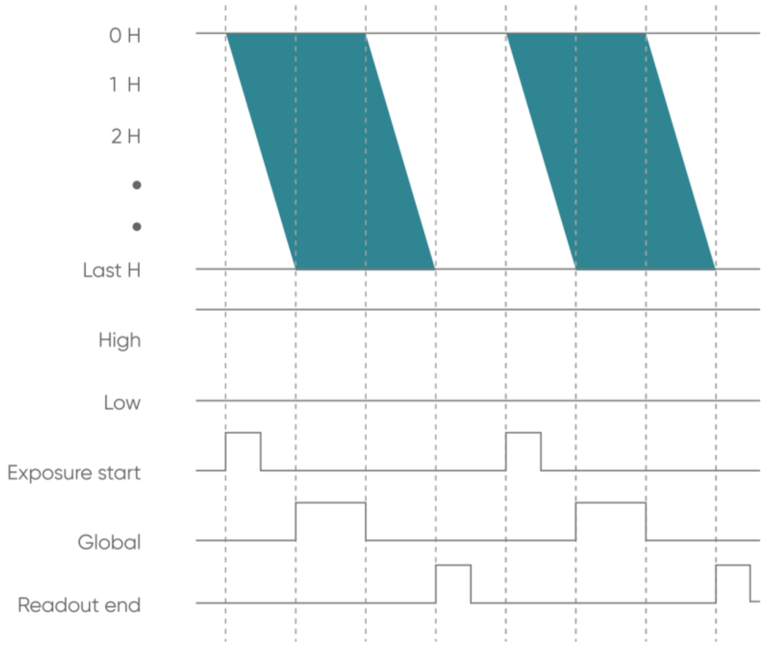


Figure 3-25 Trigger output timing diagram

- **High**: always output high level.
- **Low**: always output low level.
- **Exposure Start**: When the exposure of the first row begins, an output level signal is generated, with a default pulse width of 5 ms that can be customized.
- **Readout End**: An output level signal is generated with a default pulse width of 5 ms, which can be customized, when the last row finishes reading out.
- **Global**: From the start of exposure of the last row to the end of exposure of the first row(valid when the exposure time is larger than the readout time).

3.16. Cooling

The camera's cooling system effectively reduces dark current noise and the impact of hot pixels. The camera utilizes semiconductor cooling, employing the Peltier effect, where an N-type and P-type material form a thermocouple. When a DC current passes through the thermocouple, heating and cooling occur at the junction depending on the direction of the current. The cold side of the thermocouple is placed close to the sensor chip to lower its temperature and reduce dark current, while the hot side is connected to a metal heat sink to dissipate the generated heat.

The Dhyana XV95 utilizes water cooling for heat dissipation, achieving cooling effects up to a 65°C temperature difference from the water temperature (refer to Sections 4.1 & 4.2 for water cooling installation details).

4. Hardware Installation

4.1. Camera Installation

Please check the packaging list in section 2.1 to ensure no camera accessories are missing. If any accessories are missing, please contact the distributor. If all accessories are present, install the camera in the following order.

4.1.1. Reference for correct camera orientation

The front of the XV95 is marked with the column (H-axis) direction for reference.

(1) When attaching a standard lens, install it with the H-axis direction (silver arrow direction) facing up. In this orientation, the image displayed by the software will be upright and horizontally equivalent to the human eye.

(2) When using the camera without a lens and pointing the sensor directly at the object, install it with the H-axis direction (silver arrow direction) facing down. In this orientation, the image displayed by the software will be upright and horizontally equivalent to the human eye.

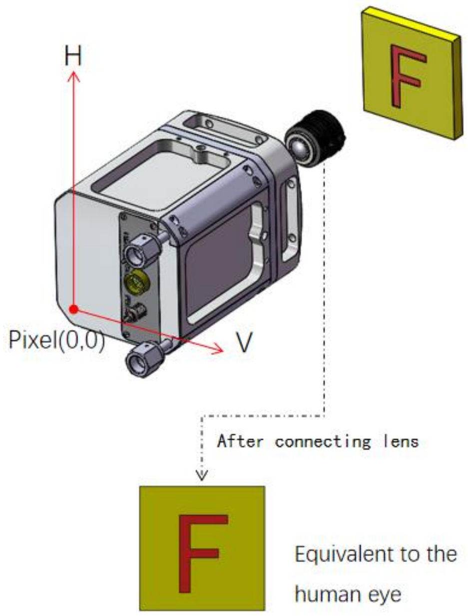


Figure 4-1 Correct installation orientation for the XV95 camera

4.1.2. Installing the main unit

(1) Remove the protective film from the front of the window, exposing the window on the protective cover assembly. This can be used for preliminary image inspection, but do not turn on TEC cooling at this stage.

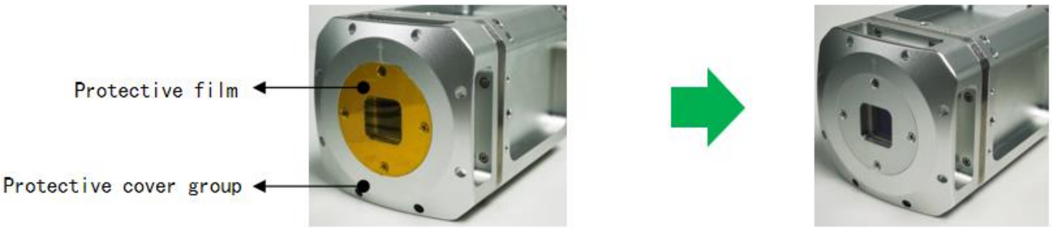


Figure 4-2 Protective cover of the XV95 camera

(2) According to your actual usage requirements, remove the detachable protective window or shell. As shown in Figure 4-3, remove the eight M4 hex screws around the protective cover to expose the camera's mounting surface. (*After this step, the camera sensor will be exposed to the environment, risking contamination or damage. Perform this operation in a clean room.)

(3) Fix the camera into the vacuum chamber. As shown in Figure 4-3, use the eight M3 threaded holes on the mounting surface or the eight M4 threaded holes or four 1/4-20UNC threaded holes on the side of the camera to secure it.

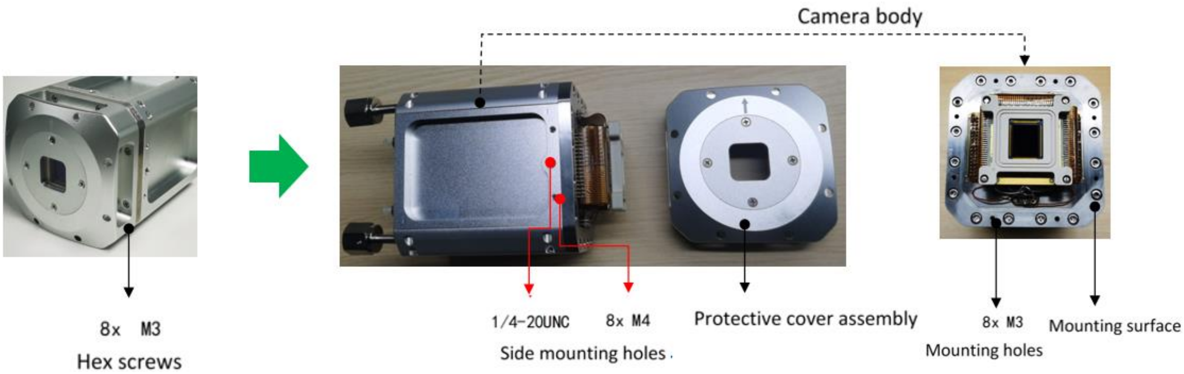


Figure 4-3 Mounting and fixing holes for the XV95 camera

***Note:**

1) Ensure this process is performed in a dust-free environment.

2) If testing in a non-vacuum environment, do not remove the protective cover.

4.1.3. Connecting the control box

(1) Take out the AC power cord and insert it into the AC power socket at the back of the control box.

Figure 4-4 Control Box with power cord connected

(2) Take out the vacuum chamber external cable and connect one end of the 8-pin cable to the Power socket on the front panel of the control box (see Figure 4-5). Align the plug with the socket notch, insert the plug, hold the plug tail with one hand, and tighten the plug's thread with the other hand by turning it clockwise (see Figure 4-6).

Figure 4-5 The vacuum cable (left) and the front (right) of the control box (Outlined in red is the power socket)

Figure 4-6 Power trigger cable connection

(3) Take out the vacuum chamber external fiber optic cable and insert the LC connector end into the optical socket on the front panel of the control box (see Figure 4-7). A "click" sound indicates successful insertion and locking.

Figure 4-7 Connecting the LC fiber optic connector

(4) Take out the USB 3.0 cable, insert the Type-B end into the USB socket on the front panel of the control box, and insert the Type-A end into the computer.

(5) For the trigger cable(Optional product) operation, take out the trigger cable and insert the 6-pin connector into the trigger socket on the front panel of the control box, connecting the other end to the trigger signal generator.

Figure 4-8 Control box with all cables connected

4.1.4. Flange Installation

Connecting the flange on the atmospheric side:

(1) After connecting the vacuum chamber external power cable to the control box, connect the other end to the 8-pin aviation socket on the flange. Align the plug with the socket notch, insert the plug, hold the plug tail with one hand, and tighten the plug's thread with the other hand by turning it clockwise.

Figure 4-9 Atmospheric Side Flange Interface

(2) Connect the FC connector (A, B) of the vacuum chamber external fiber optic cable to the corresponding FC connector adapter (A, B) on the flange. Ensure the connectors are aligned and locked (see Figure 4-10). The fully connected state of the atmospheric side of the flange is shown in Figure 4-11.

Figure 4-10 Connecting the FC connector

Figure 4-11 Atmospheric side of flange with connected cables

Connecting the flange on the vacuum side:

(1) Before connecting the cables, fibers, and water cooling pipes to the back of the flange, place the CF100 copper gasket in the CF knife-edge position (see Figure 4-12).

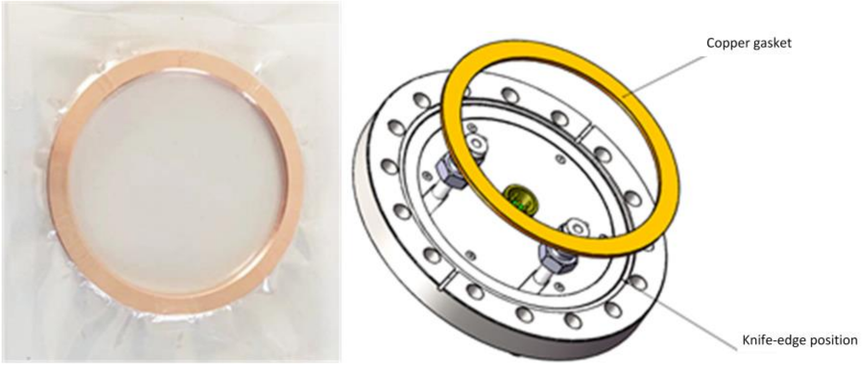


Figure 4-12 Installing the Copper Gasket

(2) Take out the vacuum chamber internal cable and connect the aviation plug end to the aviation socket on the flange. See section 4.1.8 for detailed connection instructions.

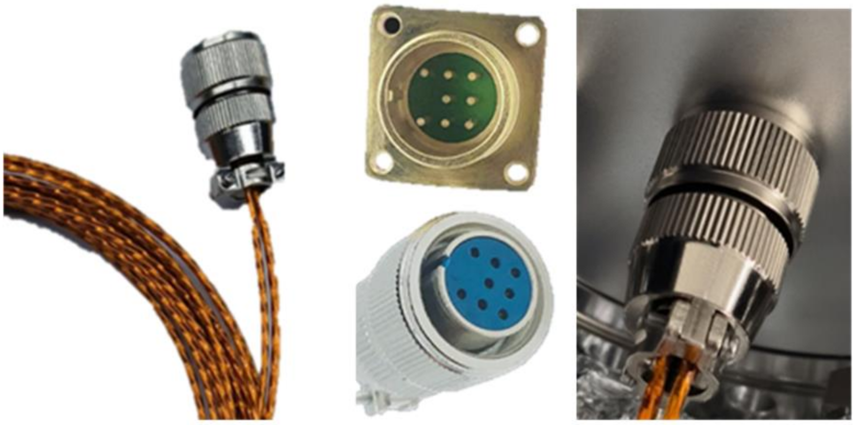


Figure 4-13 Connecting the aviation plug , the left side is the cable in the vacuum chamber, the middle and upper part is the schematic diagram of the vacuum side flange interface, the middle and lower part is the schematic diagram of the corresponding interface of the cable, and the right side is the connection diagram of the vacuum cable

(3) Take out a vacuum chamber internal fiber optic cable and connect the FC connector end to the corresponding FC connector adapter on the flange. Repeat the process for the other fiber optic jumper. See section 4.1.7 for detailed instructions on connecting FC fiber optic connectors.

(4) Take out a vacuum chamber internal VCR water cooling corrugated hose and connect the female thread end to the male thread of the water cooling pipe on the flange (ensure a VCR gasket is installed in the middle of the connector). Connect the other VCR water cooling corrugated hose to the flange. See section 4.1.10 for detailed instructions on connecting VCR water cooling connectors.

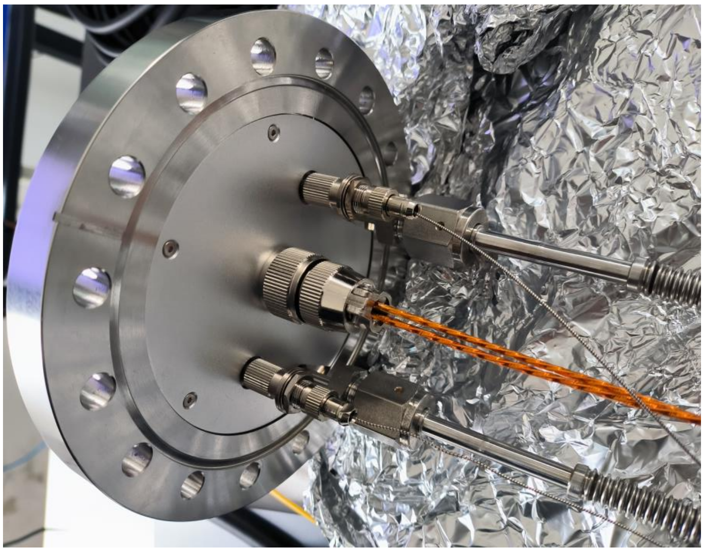


Figure 4-14 Fully connected vacuum side of the flange

Note:

If conditions permit, test the connection outside the vacuum chamber before moving the connected camera and flange into the vacuum chamber for installation and fixing. Finally, remove the dust protection cover and film. Ensure the water cooling system is on before turning on the camera cooling to avoid damage.

4.1.5. Connecting the Camera

(1) Connect the other end of the vacuum chamber internal cable, which is already connected to the flange, to the 8-pin aviation socket on the camera, ensuring it is locked after connection.

(2) Connect the other end of the vacuum chamber internal fiber optic patch cables (A, B), already connected to the flange, to the corresponding ports (A, B) on the camera. See section 4.1.7 for detailed instructions on connecting FC fiber optic connectors.

(3) Connect the vacuum chamber internal water cooling corrugated hose, already connected to the flange, to the VCR connector on the camera. See section 4.1.10 for detailed instructions on connecting VCR water cooling connectors.

Figure 4-15 The camera with cables, optical fibers, and water cooling pipes connected

4.1.6. Tightening the CF100 flange

Steps:

(1) Prepare the following materials and tools.

Materials:

①304 stainless steel M8*40 hex socket bolts (length based on actual requirements), M8 nuts, M8 flat washers, 16 each (external hex bolts can also be used);

②CF100 copper gasket, 1 piece.

Tools:

①Cleanroom gloves; ②Alcohol; ③Super clean cloth; ④8 mm hex wrench.

(2) Put on cleanroom gloves and use a super clean cloth dipped in alcohol to wipe the copper gasket and the camera flange. After wiping, carefully place the copper gasket on the knife edge of the blank flange.

(3) Use a super clean cloth dipped in alcohol to wipe the knife edge of the chamber flange. Align the blind flange (with the copper gasket) with the chamber flange, ensuring the leak detection ports are aligned.

(4) Insert the hex socket bolts with washers into the through holes and tighten the bolts into the nut plates (or M6 nuts) in a cross pattern. Refer to the figure below for the tightening sequence.

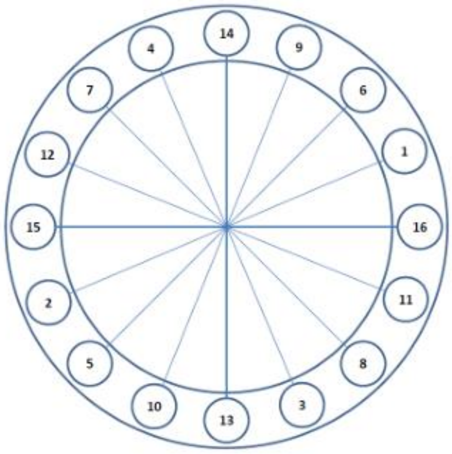


Figure 4-16 Bolt tightening sequence

Note:

During steps 2 and 3, check for any damage or scratches on the sealing knife edge and the copper gasket. If any issues are found, stop the installation. Defects in the copper gasket or flange can result in inadequate vacuum and potential damage to the flange.

4.1.7. Connecting the FC fiber optic connector

(1) Observe the FC connector on the fiber optic cable and the FC adapter. The FC connector has a protrusion on its side, and the FC adapter has a corresponding slot.

(2) When connecting the connector to the adapter, align the protrusion on the FC connector with the slot on the FC adapter and insert.

(3) Tighten the threaded sleeve at the end of the FC connector to ensure stability and complete the fiber optic connection.

Figure 4-17 FC fiber optic connection (insert the slot after alignment)

4.1.8. Power cable connection steps

(1) Observe the 8-pin aviation connector and socket. The aviation connector has a slot on its side, and the aviation socket has a corresponding protrusion.

(2) When connecting the connector to the socket, align the slot on the connector with the protrusion on the socket and insert.

(3) Tighten the threaded sleeve at the end of the aviation connector to ensure cable stability.

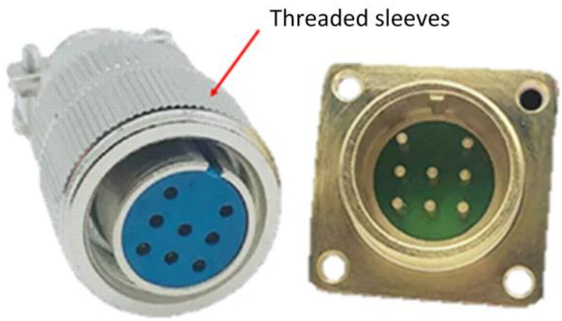


Figure 4-18 Connection of the aviation socket

4.1.9. Using the internal water cooling corrugated hose

The new structure of the Dhyana XV95 supports some degree of flexible bending of the internal water cooling hose. To adjust the bending position, follow these steps:

(1) As shown in the figure, remove the screws on the camera body.

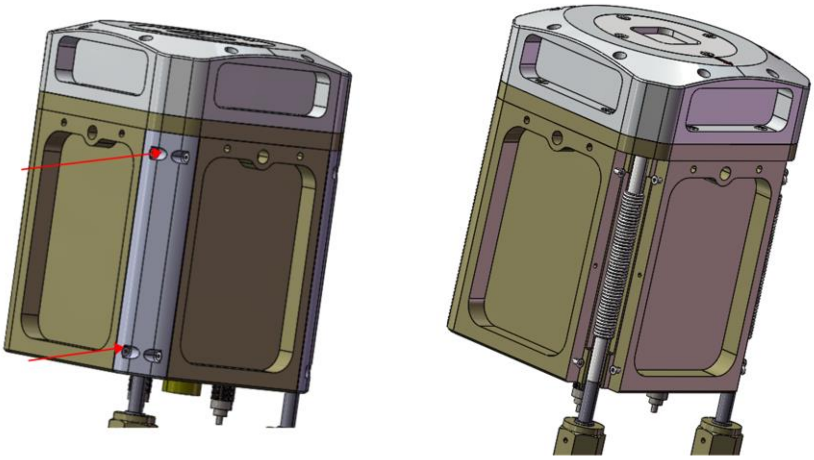


Figure 4-19 Schematic diagram of the position of the corrugated hoses of the XV camera

(2) Expose the corrugated hose, adjust its position, and then proceed with the VCR connector installation.

Warning:

The corrugated hose has limited flexibility. Familiarize yourself with section 6.3 on the maintenance of cooling hoses and connectors before operation to avoid hose rupture and camera damage.

4.1.10. Connecting the water cooling VCR connector

Ensure the VCR surface is clean and intact before operation.

Figure 4-20 Check the cleanliness of the VCR connector

Steps:

(1) Align the male VCR connector on the water cooling hose with the female VCR connector on the camera.

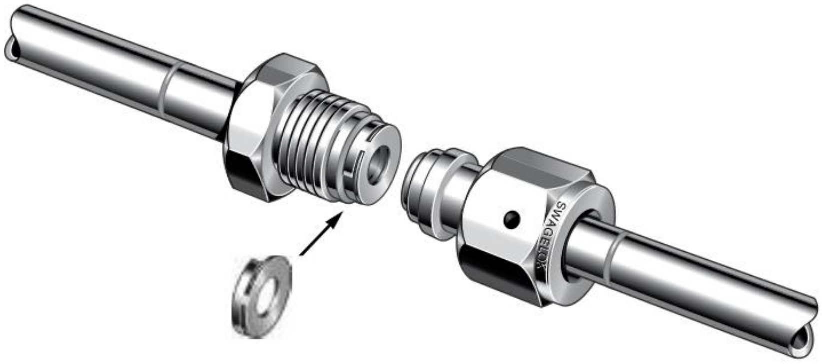


Figure 4-21 Schematic diagram of the connection sequence of the VCR connector

(2) Install the clawed nickel gasket on the VCR connector.

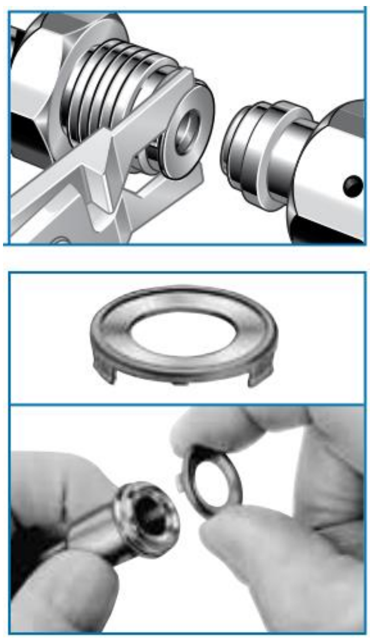


Figure 4-22 Installation of the clawed nickel gasket

(3) Align the male and female connectors along the central axis and connect.

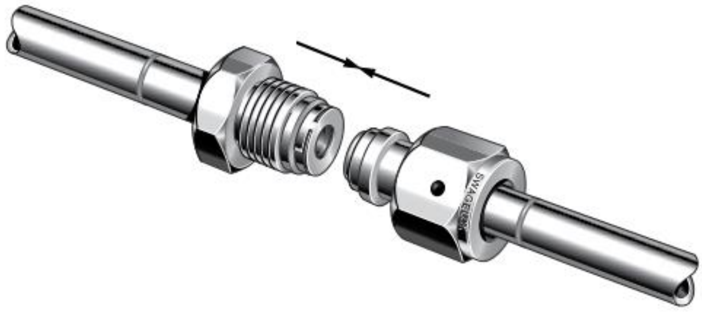


Figure 4-23 Align the VCR connectors

(4) Tighten by hand until you cannot turn it further.

Figure 4-24 Manual operation

(5) Use a wrench to tighten further, turning the nickel gasket only 1/8 of a turn.

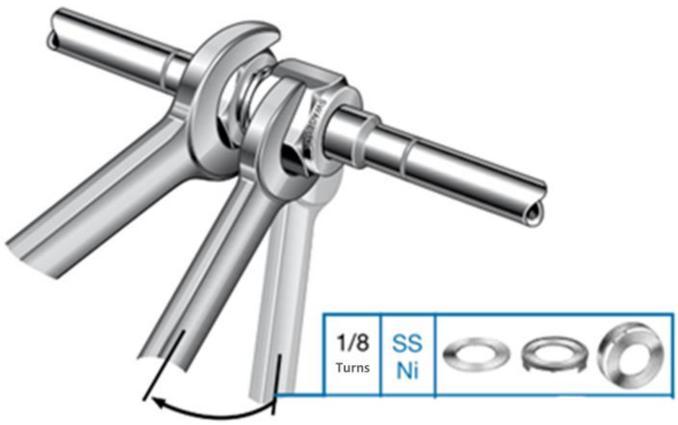


Figure 4-25 Wrench operation

(6) After completing the water cooling circuit connection, use a leak detector to confirm the connection status.

Note:

All illustrations in this section are from Swagelok product descriptions (reference link：https://www.swagelok.com.cn/downloads/webcatalogs/cn/ms-01-24.pdf）.

4.1.11. Leak and water flow testing

Install the water hose fitting from the accessories into the M5 water hose port on the flange. Use a helium mass spectrometer to check for leaks in the water cooling circuit. After leak testing, connect the circuit to the water chiller. Ensure the vacuum side of the water cooling circuit is well sealed to avoid water leaks that could damage.

4.2. Installation of external water cooling pipes

4.2.1. Connecting the water cooling pipes

(1) Place the camera on a stable workbench.

(2) Connect the water cooling pipes to the water pipe connectors on the camera, ensuring a proper fit as shown in the figure below.

Figure 4-26 Camera end water pipe connector

(3) Insert the water pipes into the nozzles of the cooling water circulator*, ensuring a proper fit as shown in the figure below.

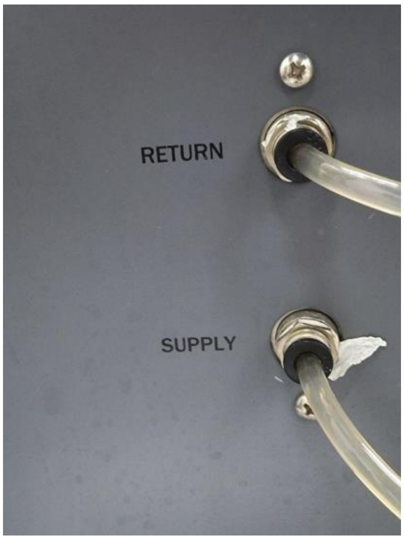


Figure 4-27 Cooling water circulator end water pipe connector

***Water Cooling Circulator Usage Notes：**

1) It is recommended to use deionized water.

2) The minimum water flow should be ⩾ 1 L/min, and the maximum water pressure should be ⩽ 2 bar.

3) The water temperature should be set above the dew point to prevent condensation water pipes and other water-cooling equipment. (see Appendix 3 for the dew point table).

4.2.2. Disconnecting the water cooling pipes

(1) Disconnect the power supply to the camera and all other equipment, including the cooling water circulator.

(2) According to the instructions of the cooling water circulator, drain the water from the circulator.

(3) Press the sliding sleeve of the transfer valve and pull out the cooling water circulator hose to drain the internal water.

(4) Press the water connector and pull the camera water pipe out of the water pipe connector. First, orient the installed water valve to the side (not upwards). When pulling out the water pipe, make sure the valve port faces downwards. Use an absorbent towel or paper towel to protect the area and ensure no water leaks into the camera.

5. Software Installation

5.1. Recommended computer configurations

Camera Interface	USB 3.0
CPU	I5 and above performance, with a main frequency of 2.6GHz and above
Operating system	Windows 10/11 64 bit PC
Memory	8GB and above

5.2. Driver installation and uninstallation

This section will introduce the installation of camera USB driver and uninstallation.

Operation steps:

(1) Connect the camera to the computer and open the matching USB drive;

(2) Double click to run the driver installation package;

(3) Follow the prompts to click [Next] for default installation;

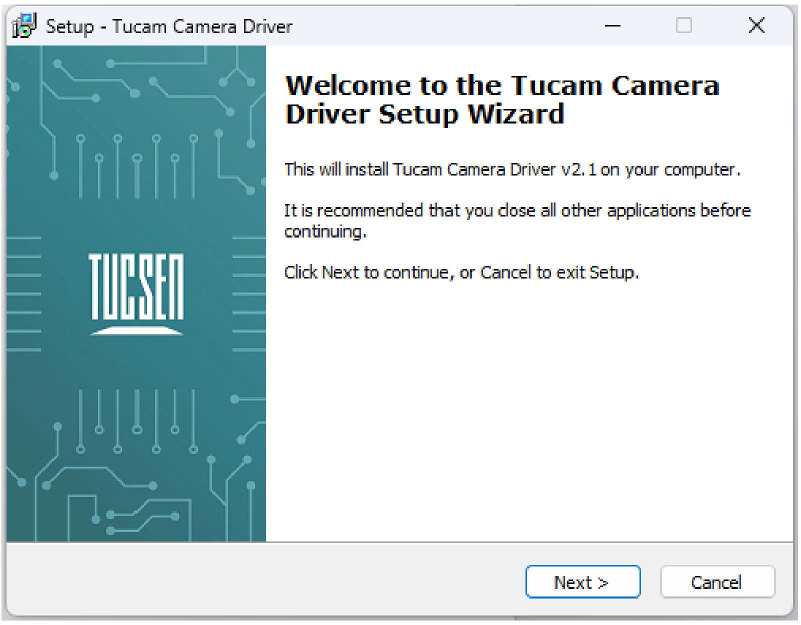


Figure 5-1 The driver installation start page

(4) Selecting the contents of the installation, by default check the box to install Microsoft runtime libraries vcredist_2008 and vcredist_2013, unchecking the box may result in the software or third-party plug-ins not working;

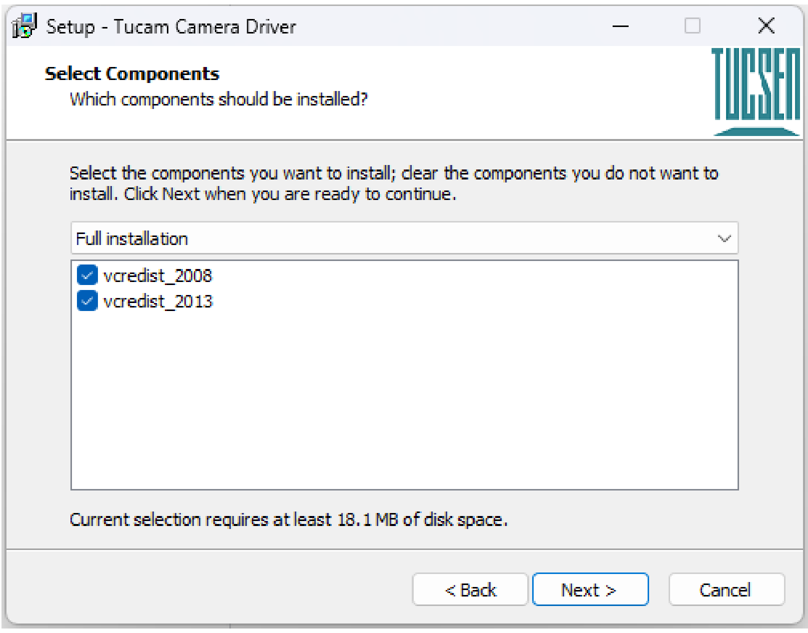


Figure 5-2 Optional installation content

(5) Waiting for the driver installation to be completed;

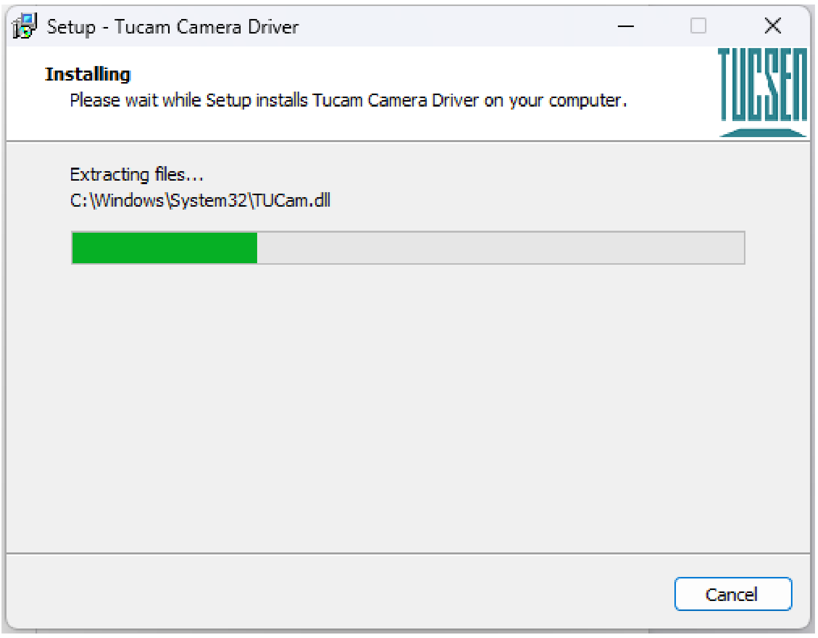


Figure 5-3 Under driver installation...

(6) Click "Finish" to complete the driver installation;

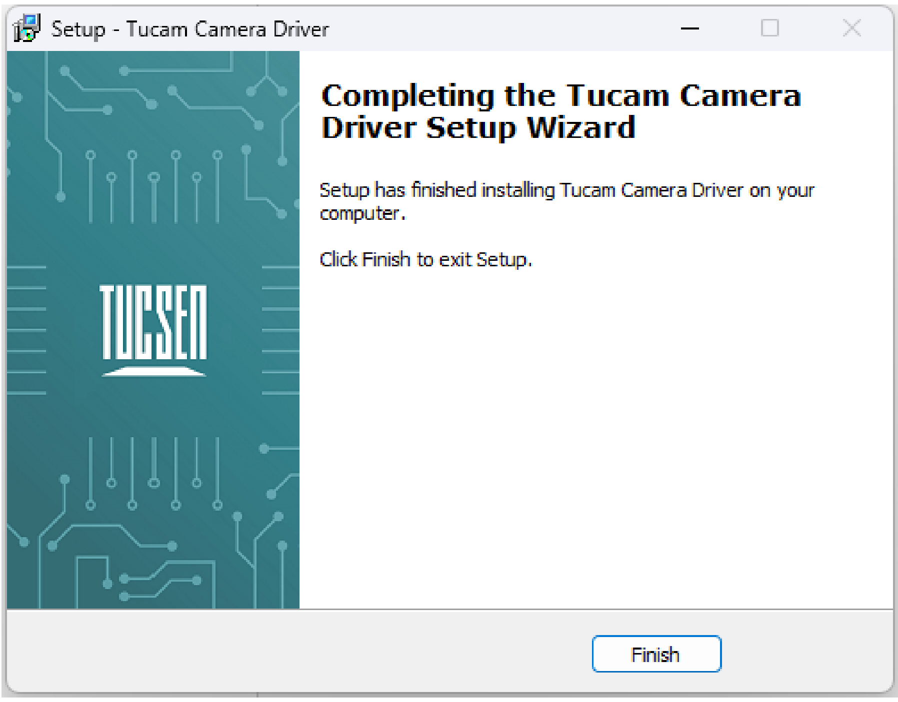


Figure 5-4 Finish the installation

After installing the camera USB 3.0 driver, open the device manager on the computer. When the driver is successfully installed, the camera will appear under the image device without any yellow markings, as shown in the picture. If a yellow symbol appears, it indicates that the driver needs to be reinstalled.

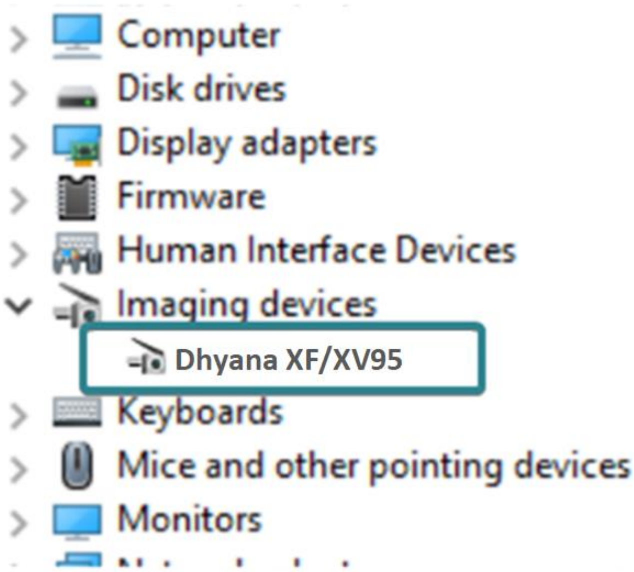


Figure 5-5 XV95 display in device manager

5.3. Software installation and uninstallation

5.3.1. Installation

Operation steps:

(1) Open the supporting USB drive, double-click to run Mosaic V3 software;

(2) Select the installation path, default to C drive, users can customize the installation path according to your needs;

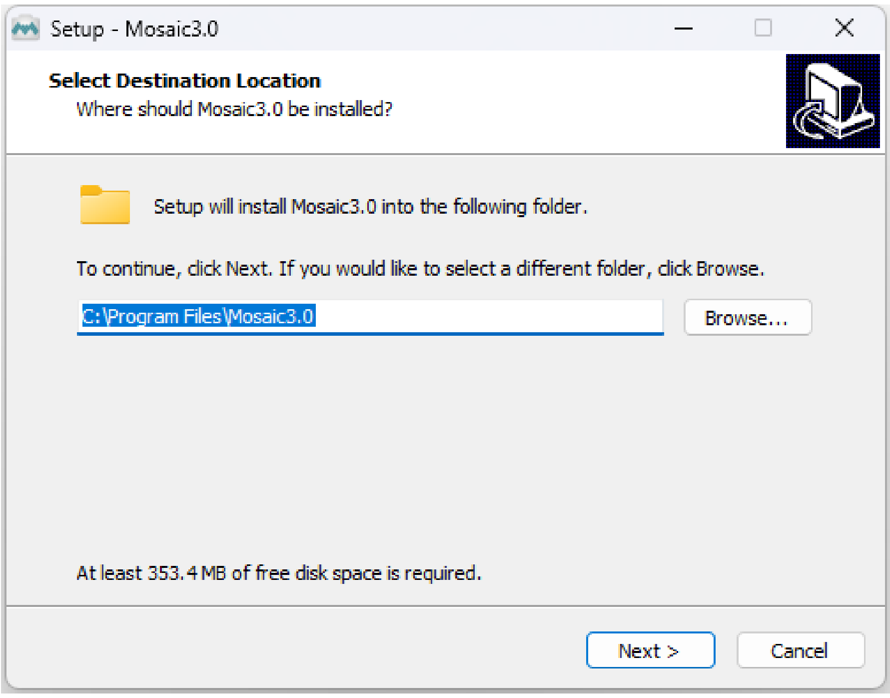


Figure 5-6 Installation of Mosaic V3

(3) Select the installation content. By default, select the option to install drivers, canceling the installation can result in the camera not being recognized by the software;

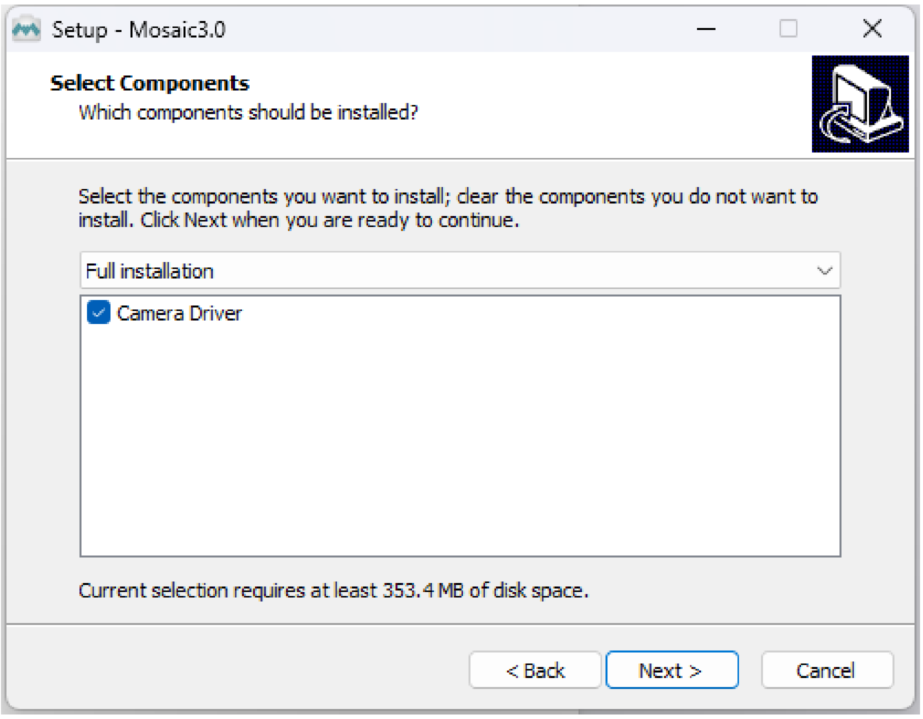


Figure 5-7 Check the camera driver

(4) Configure installation parameters and select whether to generate desktop shortcuts;

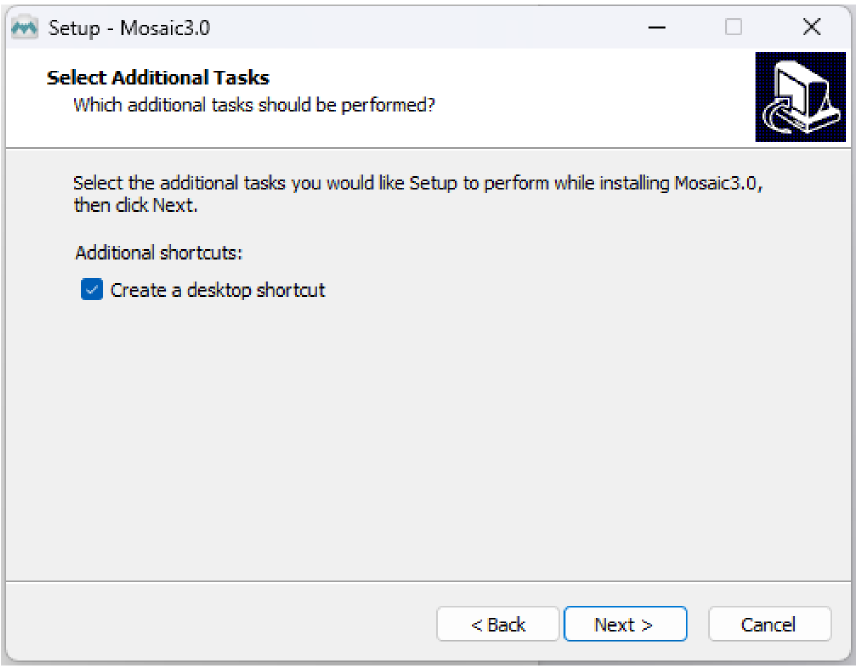


Figure 5-8 Check to create a desktop shortcut

(5) After confirming all installation parameters, click "Install" to start executing the installation action;

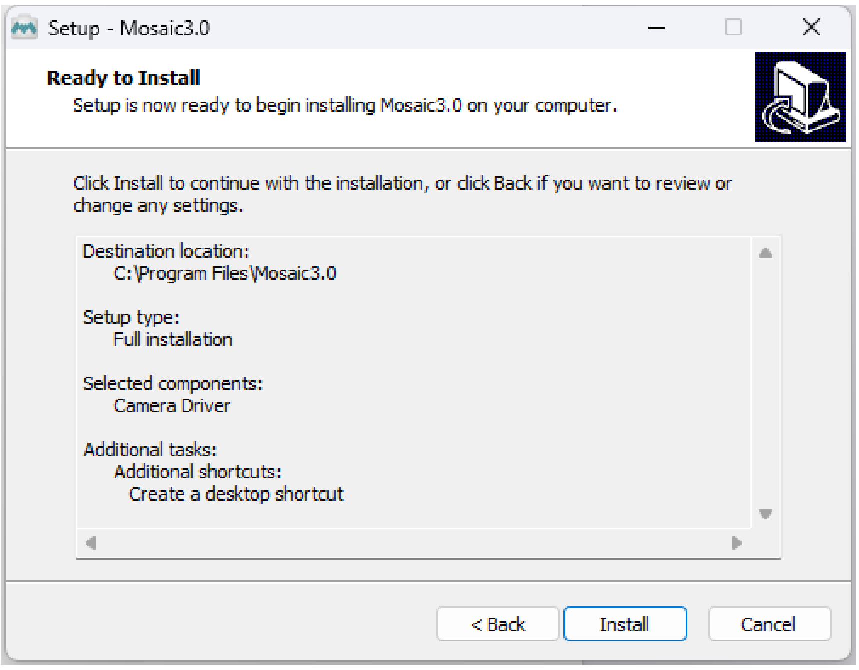


Figure 5-9 The page for settings check

(6) Waiting for installation to complete;

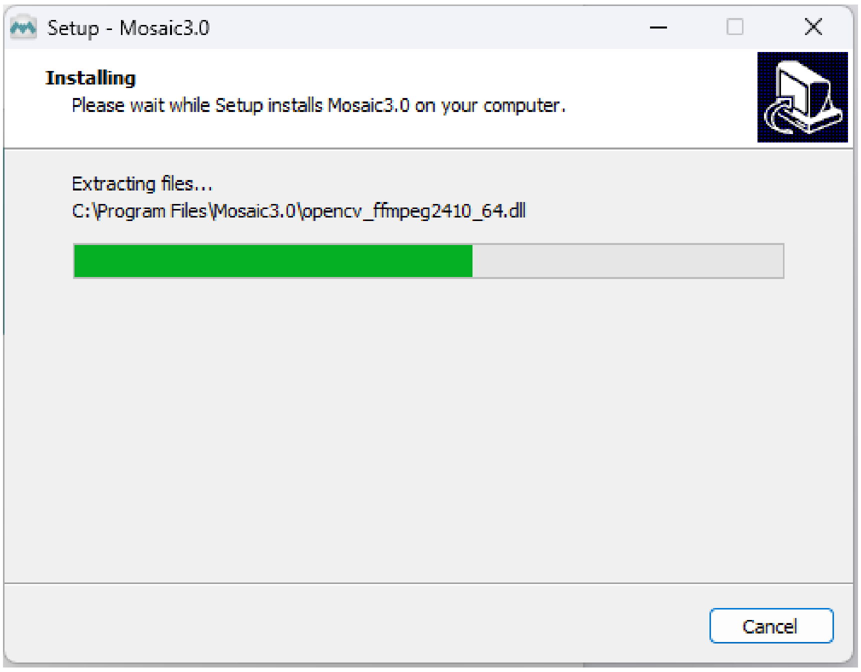


Figure 5-10 Software installing...

5.3.2. Uninstallation

There are three ways to uninstall Mosaic software:

(1) By uninstalling through the installation package, the existing version on the computer will be uninstalled when the installation package runs, and the default C drive path will take effect;

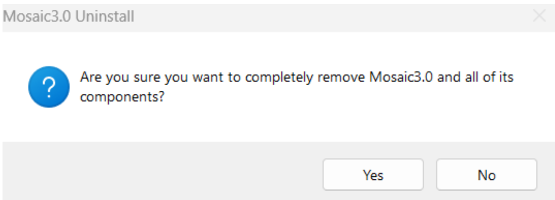


Figure 5-11 Uninstalling through installation package

(2) Under the installation path, find unins000.exe to uninstall, double-click uninstall;

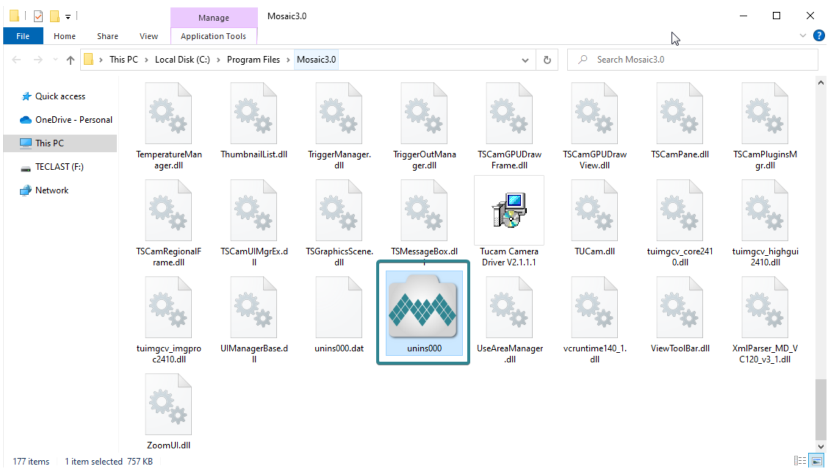


Figure 5-12 Uninstalling through installation path

(3) Uninstall from the computer program management interface;

Note:

After uninstalling and reinstalling the software, all software configuration information and calibration table data will be deleted.

6. Maintenance

Damage caused by unauthorized maintenance or procedures will void the warranty.

6.1. Regular inspection

Regularly check the condition of the product, especially the integrity of external power and main cables. Do not use damaged equipment.

6.2. Electrical safety inspection

- It is recommended to check the insulation and protective grounding integrity of the AC/DC converter every year
- Do not use damaged equipment

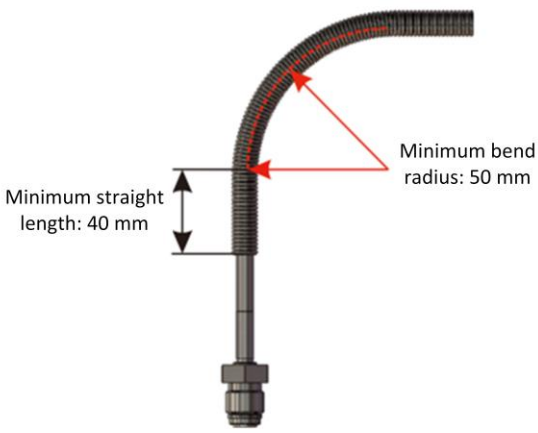
6.3. Cooling hoses and connectors

Users should regularly check all coolant hoses and connections for signs of leakage, damage, or wear. All seals must be intact before the camera system can be turned on, and any worn or damaged components must be replaced immediately.

Camera cooling hose (corrugated hose) usage notes

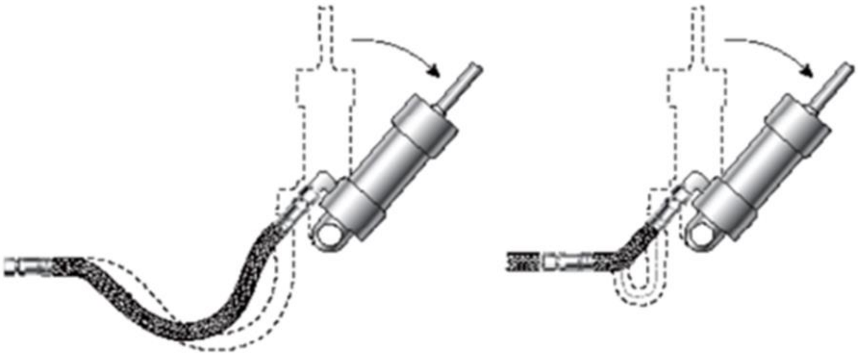
(1) Minimum Bend Radius

- The minimum bend radius requirement of the corrugated hose must be observed. An installed hose with too small a bend radius can lead to shortened hose life or even breakage.
- Bends too close to the hose connectors may cause the hose to break, so a minimum straight length must be maintained during installation.



(2) Motion Absorption

- Use sufficient hose length to distribute movement and prevent bends smaller than the hose's bend radius.



Recommened Not Recommened

(3) Motion Tolerance

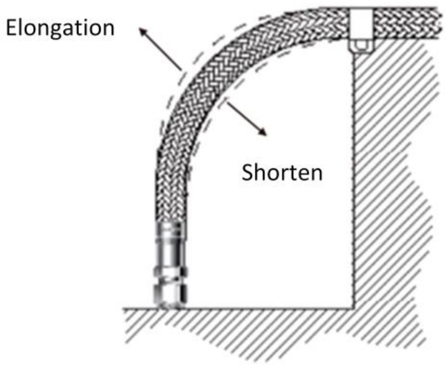
- Consider the length changes caused by motion and tolerance.

Recommened

Not Recommened

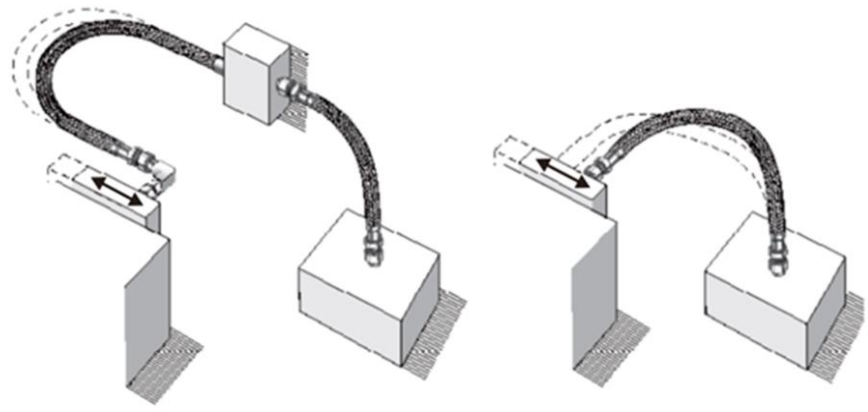
(4) Pressure Variations

- Sufficient hose length should be used to accommodate system pressure changes.
- High and low-pressure hoses must not be connected together.



(5) Bending in the Same Plane

- Hose bending should occur in the same plane to avoid twisting. For complex bends, use multiple hose sections or other isolation measures.

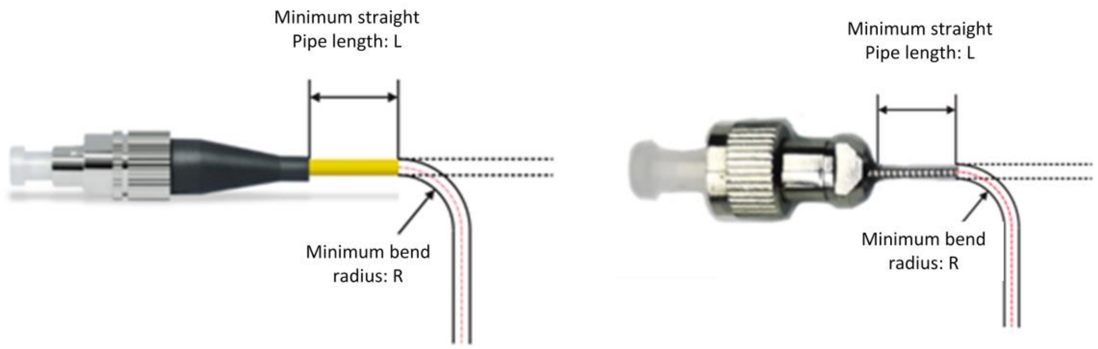


Recommened   Not Recommened

6.4. Fiber optic patch cable usage notes

(1) Minimum Bend Radius

- During use, ensure that the minimum bend radius without load is R > 15mm; the minimum straight length (connector end) L > 20mm.



(2) Cleaning and Protection

- Ensure cleanliness before use and maintain usage in a clean environment.
- If dirty, clean the ceramic ferrule and end face of the optical fiber with alcohol and lint-free cotton before use.
- Protect the ferrule and end face during use to prevent damage and contamination. Attach protective caps promptly after disassembly.

(3) Optical Fiber Connectivity Detection

- The connectivity of the optical fiber can be checked with a visual fault locator (red light pen). A properly functioning optical fiber should not exhibit any light leakage.

Red light pen   Location of light leakage

No red light at the outlet

7. Troubleshooting

7.1. Computer unable to recognize the camera

(1) Ensure the camera is properly powered on.

(2) Confirm the camera is correctly connected to the computer:

- For USB connection, use the USB 3.0 port on the back of a desktop computer.
- For fiber optic connection, ensure that the A and B cables are connected correctly.

(3) Check that the driver is functioning properly.

7.2. Software pauses or freezes

(1) The computer may have turned on the energy-saving mode, the system CPU performance is reduced, resulting in the software can not work properly, there are dropped frames or software jamming and so on. You can check to ensure that the computer is in high-performance mode.

(2) The computer has opened too many applications, resulting in the computer CPU occupation is too high, the software CPU utilisation is low and can not work properly. Can close the redundant applications.

(3) Data cable connections may be loose or extended too far, leading to unstable software operation. Check and secure all data and fiber optic cables.

7.3. Camera fails to reach target cooling temperature

(1) Verify if the water temperature is too high; the camera's maximum cooling difference is 65°C below ambient temperature (for water cooling).

(2) Check if the water cooling circulation channel is blocked.

(3) Ensure the water cooling unit is operating correctly.

7.4. Frame rate not reaching specified value

(1) Check if the exposure time affects the frame rate. Set the minimum exposure time to verify.

(2) The specified frame rate is based on ideal bandwidth conditions; actual usage frame rates may vary due to data transmission impacts and the type/length of the data interface used.

(3) Confirm the correct data transfer interface is used. USB connections should use USB 3.0 ports. Using non-3.0 ports can result in lower frame rates.

(4) If using a USB 3.0 port but involving hubs/extensions/adapters, the frame rate may not reach the specified value.

8. FAQs

8.1. Why is the brightness of the captured image inconsistent with the preview window?

When using the camera for the first time and the target is dark, the software preview may show an all-black image. It is recommended to check Auto Left Scale (Auto Min) and Auto Right Scale(Auto Max) in the Histogram setting area, in which case the software preview will show the most suitable brightness and contrast. However, when you save the image, the default image saved by the software will not save the effect of auto colour gradation, resulting in inconsistency between the preview image and the captured image.

You can try the following solutions:

(1) Disable the automatic colour gradation function of the software, the preview image will be consistent with the saved image;

(2) Use professional image viewing tools such as ImageJ to open the tif image and adjust the colour gradation.

(3) Use Mosaic V3 software to tick "Save the Adjusted Image" in the Capture section (can be used when you don't need the original image data value).

8.2. Stripe like flicker appears in the camera preview image

May be caused by an unsynchronised external light source. There may be a strobe light source in the environment, which can be judged by extending the exposure time. If it is an ambient light source, switching off the illumination source is sufficient. If from an irradiated sample light source, a regulated light source is required for illumination.

9. After-sales Support

(1) Log in to the official website, click on the [Technical Support] module, and get answers to common questions.

(2) Contact professionals for technical support:

- TEL: +86-591-28055080-818
- Email: service@tucsen.com
- Visiting the official website to leave a message: http://www.tucsen.com

(3) Please prepare the following information in advance:

- Camera model and S/N (product serial number);
- Software version number and computer system information;
- Description of the problem and any related images.

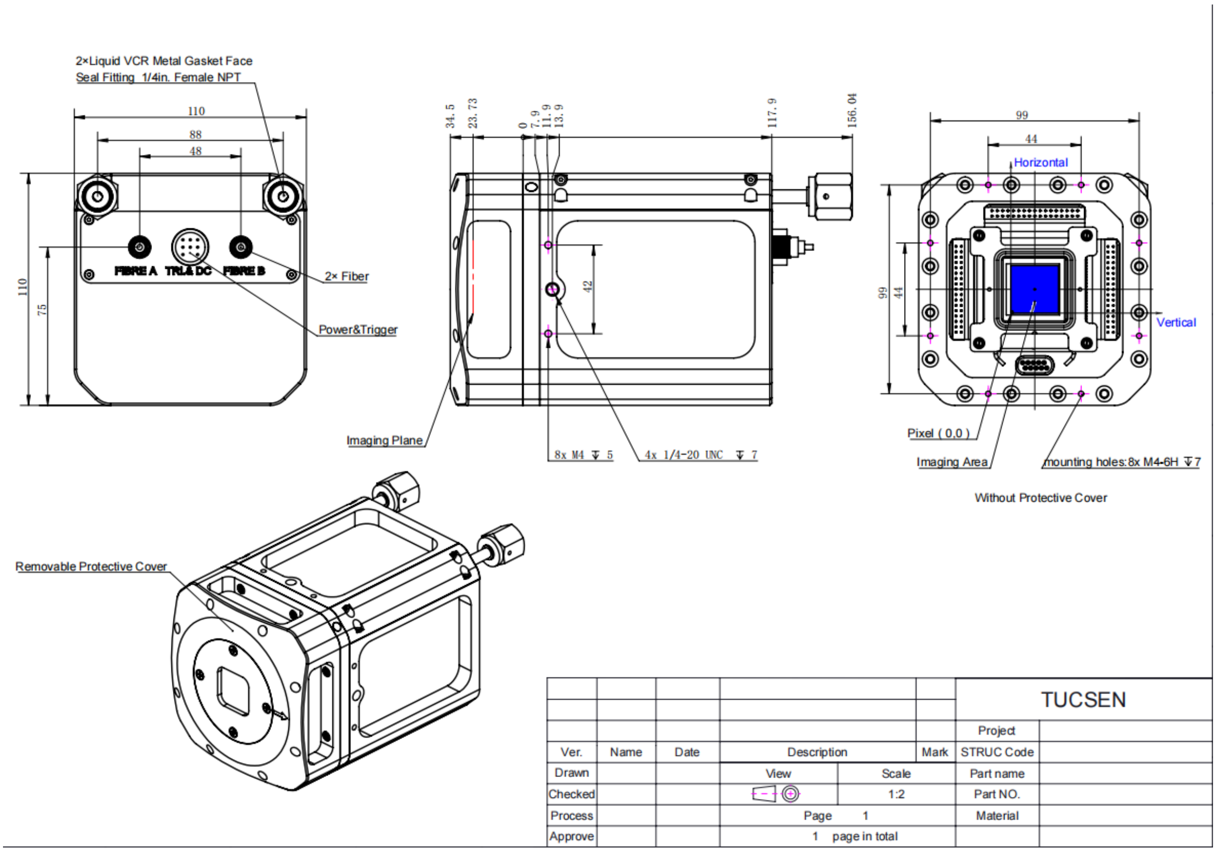
Appendix 1 : Specifications

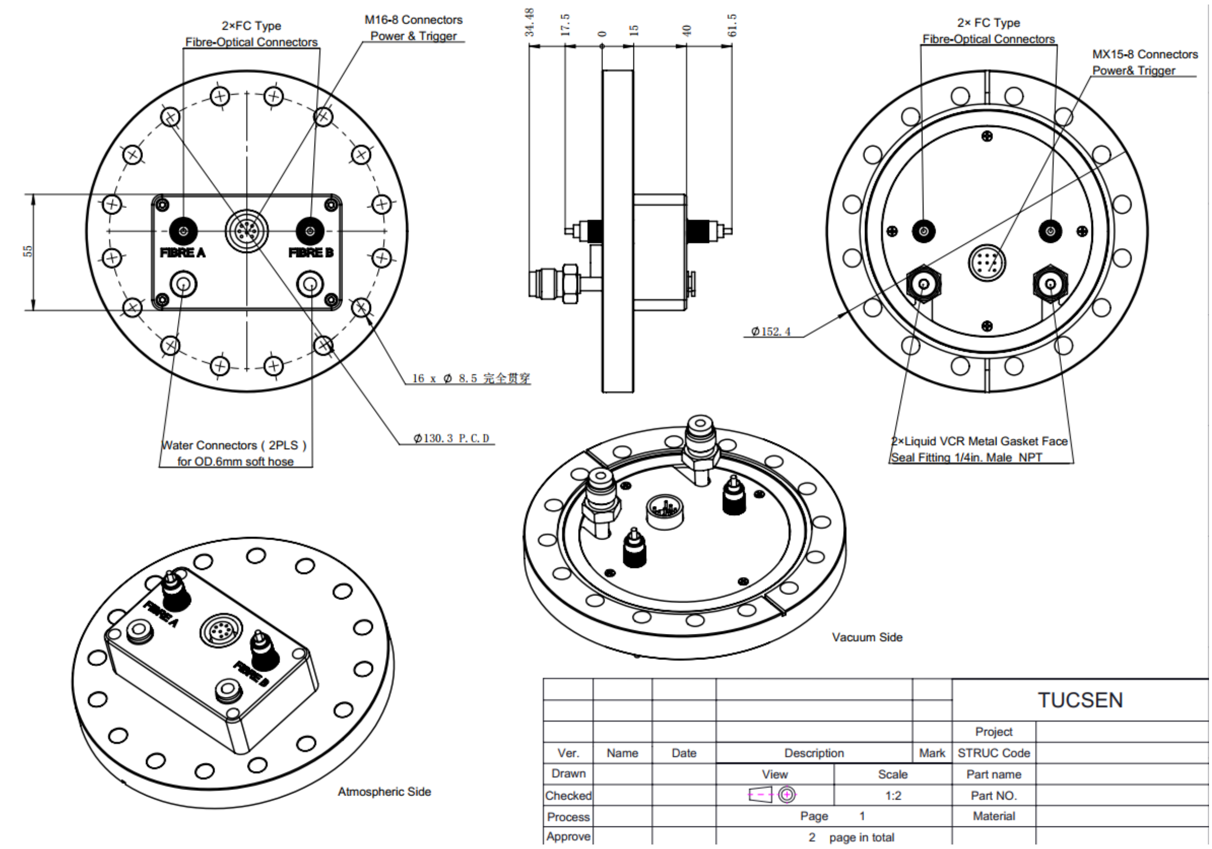
Model	Dhyana XV95
Sensor Type	BSI sCMOS
Sensor Model	GSENSE 400BSI-PS / GSENSE 400BSI
Peak QE	~100% @80-1000 eV / 95% @ 200-1100 nm
Color / Mono	Mono
Array Diagonal	31.9mm
Effective Area	22.5mm x 22.5mm
Resolution	2048(H) x 2048(V)
Pixel Size	11µm x 11µm
Full-Well Capacity	HDR：85 ke- (Typ.)
Dynamic Range	90 dB
Frame Rate	HDR: 24 fps; STD: 48 fps
Readout Noise	High Gain: 1.6 e- (Median)
Shutter Type	Rolling
Exposure Time	21 µs ~300 s
DSNU	0.2 e-
PRNU	0.3%
Bit Depth	12 bit，16 bit
Cooling Method	Liquid
Max. Cooling	65°C below ambient (Liquid)
Dark Current	0.3 e-/pixel/s @-45°C
Vacuum compatibility	1E-6Pa(Max)
Binning	2 x 2, 4 x 4
ROI	Support
Timestamp Accuracy	1 µs
Trigger Mode	Hardware & Software
Output Trigger Signals	Exposure start, Global, Readout end, High level, Low level
Trigger Interface	Hirose-6-Pin
Data Interface	USB 3.0
Power Supply	AC power
Power Consumption	Camera and control box ≤65W
Flange size	Standard DN100CF

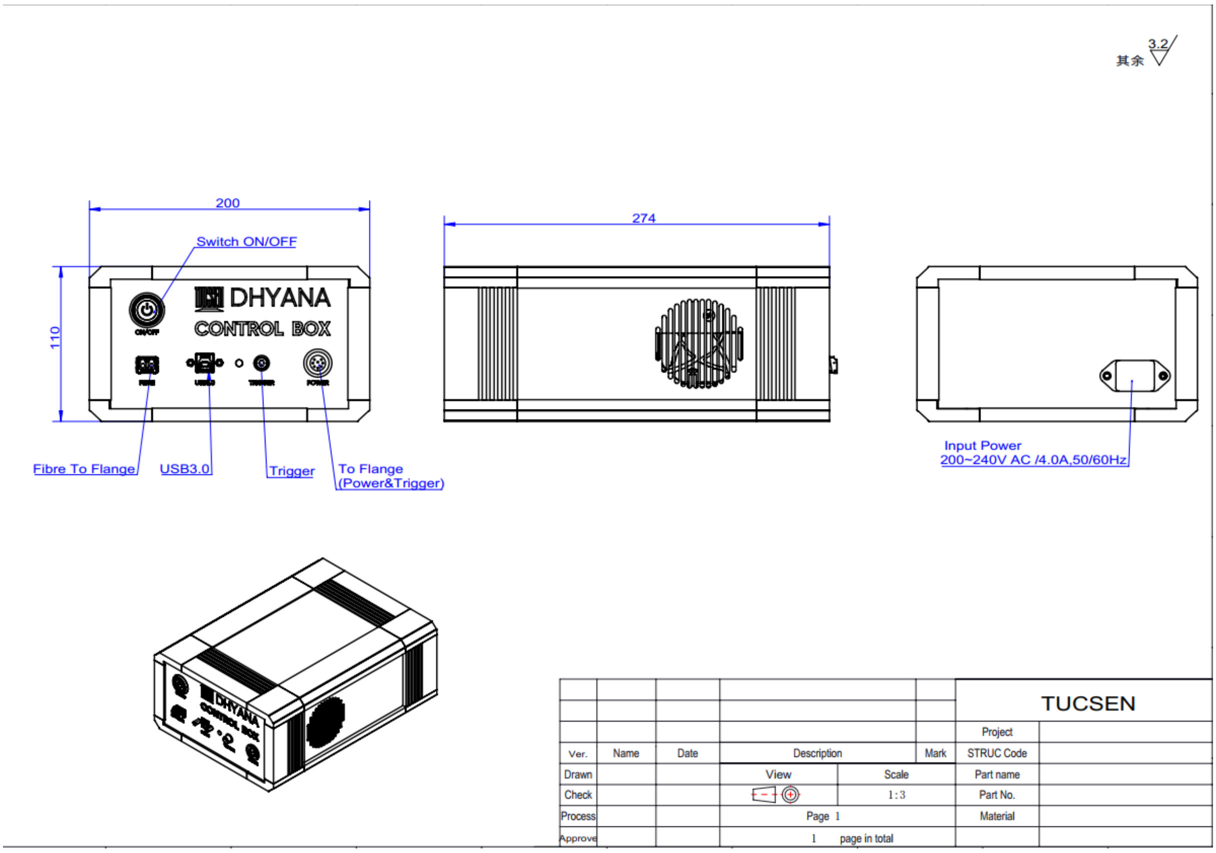
Dimensions	110mm x 110 mm x 197 mm
Weight	~2600 g
Software	Mosaic V3/Samplepro/LabVIEW/Micro-manager/Matlab
SDK	C, C++, C#
Operating System	Windows/Linux
Operating Environment	Operating Temperature: 0~40°C Humidity: 0~ 70%, no condensation; Baking Temperature: <70°C

Note: The parameters in this table are typical values and are subject to change without notice.

Appendix 2 : Dimensions






其余 3.2
200
274
110
Switch ON/OFF
DHYANA
CONTROL BOX
Fibre To Flange
USB3.0
Trigger
To Flange
(Power&Trigger)
Input Power
200~240V AC /4.0A,50/60Hz
TUCSEN
Project
Ver.
Name
Date
Description
Mark
STRUC Code
Drawn
View
Scale
Part name
Check
1:3
Part No.
Process
Page 1
Material
Approve
1 page in total

Appendix 3 : Dew point table

		Humidity							
		20%	30%	40%	50%	60%	70%	80%	90%
Temperature	5							1.8	3.5
	6							2.8	4.5
	7						1.9	3.8	5.5
	8						2.9	4.8	6.5
	9					1.6	3.8	5.7	7.4
	10					2.6	4.8	6.7	8.4
	11					3.5	5.7	7.7	9.4
	12				1.9	4.5	6.7	8.7	10.4
	13				2.8	5.4	7.7	9.6	11.4
	14				3.7	6.4	8.6	10.6	12.4
	15			1.5	4.7	7.3	9.6	11.6	13.4
	16			2.4	5.6	8.2	10.5	12.6	14.4
	17			3.3	6.5	9.2	11.5	13.5	15.3
	18			4.2	7.4	10.1	12.4	14.5	16.3
	19		1.0	5.1	8.4	11.1	13.4	16.4	18.3
	20		1.9	6.0	9.3	12.0	14.4	16.4	18.3
	21		2.8	6.9	10.2	12.9	15.3	17.4	19.3
	22		3.6	7.8	11.0	13.9	16.3	18.4	20.3
	23		4.5	8.7	12.0	14.8	17.2	19.4	21.3
	24		5.4	9.6	12.9	15.8	18.2	20.3	22.3
	25	0.5	6.2	10.5	13.9	16.7	19.1	21.3	23.2
	26	1.3	7.1	11.4	14.8	17.6	20.1	22.3	24.2
	27	2.1	8.0	12.3	15.7	18.6	21.1	23.3	25.2
	28	3.0	8.8	13.2	16.6	19.5	22.0	24.2	26.2
	29	3.8	9.7	14.0	17.5	20.4	23.0	25.2	27.2

Appendix 4 : Third party software applications

Provide plugins for calling third-party software (LabVIEW, Matlab, Micro-Manager, etc.), please click on the link to download the configuration: sCMOS and CMOS Camera Third Party Softwares -TUCSEN - Tucsen

Appendix 5 : Update log

Version	Date	Modified Content
V1.0.0	2023-12-11	Create this document.
V1.0.1	2024-09-14	Overall revision 1.Camera structural changes; 2.Control box: Added indicator lights and USB mounting screws; 3.Added camera installation orientation instructions; 4.Added precautions for using optical fiber jumpers.
V1.0.2	2024-11-22	Corrected Section 3.3 "anti-reflective coating" to "non-anti-reflective coating"
V1.0.3	2025-03-12	An example of calculating the number of high-energy photons has been added in Section 3.13.